MACHINERY.

March, 1906.

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—2.

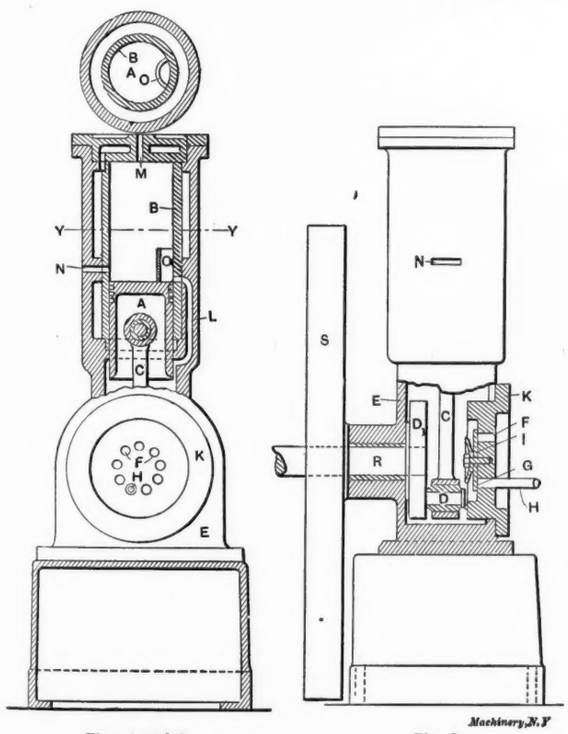
S. M. HOWELL.

In the January article of this series we referred to the English patent of J. Day, as the first complete embodiment of the modern two-cycle engine. There are, however, two Day patents and also those of two other inventors, all of which are very similar in design, differing only in certain details which will readily appear to the reader upon an inspection of the drawings. These original two-cycle patents are five in number; two, by J. Day, dated in England April 14, 1891, and in the United States July 30, 1895, and August 6, 1895; one by F. W. C. Cock, dated in England October 15, 1892, and in the United States August 6, 1895, naming J. Day as assignee of the entire interest; one by C. Sintz, dated November 21, 1893; and one by L. H. Nash in 1888. The drawings and specifications of the first four are given below and the Nash patent will be taken up later.

First Patent of Joseph Day.

In the drawings, Fig. 1 is an end view, partly in section, of a gas or vapor engine of the vertical inverted type, in which the crank works in an inclosed space in the framework. Fig. 2, above Fig. 1, is a plan section on line *Y Y*, Fig. 1. Fig. 3 is a side view partly in section.

Referring to Figs. 1, 2, and 3 the plunger or piston *A* reciprocates in the jacketed cylinder *B*, which is mounted over and connected by a connecting-rod *C* to the crank-pin *D*, which latter is mounted on the crank or crank-disk D_1 keyed onto crank-shaft *R* having fly-wheel *S*. The air and gas are drawn in from below through the casing forming the admission-



Figs. 1 and 2. Fig. 3.

Patent of J. Day, July 30, 1895.

chamber *E* respectively by air-ports *F*, communicating to the outer air, and gas-port *G* leading from the gas-supply pipe *H*, and a single disk or other suitable valve *I* does duty for the admission of both air and gas.

The air and gas, as described, enter by the valve *I* during the early portion of the upstroke and by the revolution of the crank-disk D_1 and crank *D*, and movement of the connecting-rod are intimately mixed. The explosive mixture is conveyed into the upper part of the cylinder at the end of the downstroke or early part of the up stroke by a passage *L* in the outside of the cylinder, while the piston itself serves as a slide-valve whereupon the compression of the mixture above begins, owing to the piston closing the port and thus preventing communication between the upper and lower parts of the cylinder. The ignition then takes place by any suitable igniting device having connection with the interior of the cylinder by a pipe *M*, and the plunger *A* is forced down until the exhaust-port *N* is uncovered thereby, and the majority of the products of combustion escape, while previous to such exhaust

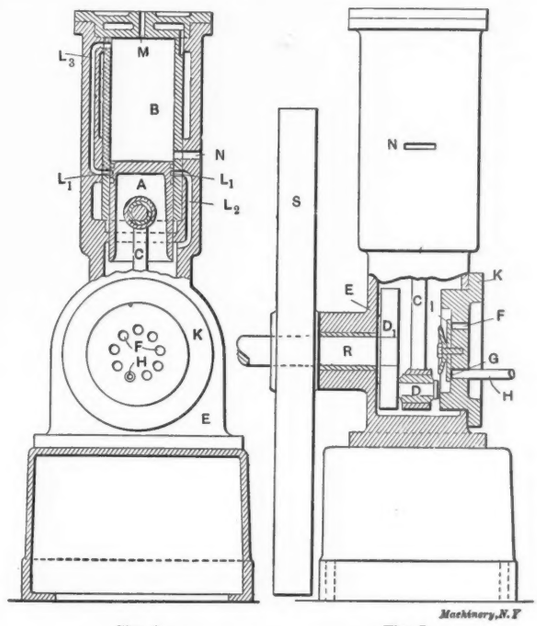


Fig. 4. Fig. 5.

Patent of J. Day, August 6, 1895.

a certain amount of compression has been given to the mixture of air and gas below in the chamber *E* in such manner that, as aforesaid, as soon as the exhaust has taken place the explosive mixture passes by way of the passage *L* into the upper part of the cylinder.

By so proportioning the size of the exhaust-port orifice, I am enabled to leave more or less of the products of combustion in the cylinder at the end of the downstroke, as desired. In order that the explosive mixture may not at the beginning of the upstroke escape by the exhaust, I provide a sort of funnel, shield, or deflector *O* on the top and at one side of the plunger, or otherwise I may make the port of the passage *L* in such manner that the explosive mixture is directed away from the exhaust-port. The cubical contents of the inclosed lower chamber and the cylinder should bear such relation to one another that, on the charge being delivered into the cylinder from the lower chamber *E*, both sides of the plunger should be at or about at atmospheric pressure.

Lubrication of the working parts and the keeping cool of the same are attained by permitting one or more of such parts to move or impinge against oil or water, or a mixture of both, in the bottom of chamber *E*. The speed of the engine may be governed by means of any suitable governing device acting on the gas-supply or otherwise.

By reason of the direct flow of the explosive mixture through the passage *L*, it becomes possible, as evidenced by actual practice, to produce with absolute certainty an ignition at each revolution, and to run the engine at a speed of as much as five hundred revolutions per minute. This has heretofore been impossible.

Second Patent of Joseph Day, Figs. 4 and 5.

The air and gas, as described, enter by the valve *I* during the early portion of the up-stroke, and by the revolution of the crank-disk D_1 and crank *D* and movement of the connecting rod are intimately mixed. The explosive mixture is conveyed

into the upper part of the cylinder at the early part of the up-stroke by the passages L_2 and L_3 and annular groove L_1 in the plunger, whereupon the compression of the mixture above begins, owing to the groove L_1 in the plunger ceasing to register with the ports of the passages L_2 and L_3, and thus closing automatically the connection between the upper and lower parts of the cylinder. The ignition then takes place by any suitable igniting device having connection with the interior of the cylinder by a pipe M, and the plunger A is forced down until the exhaust-port N is uncovered thereby, and the ma-

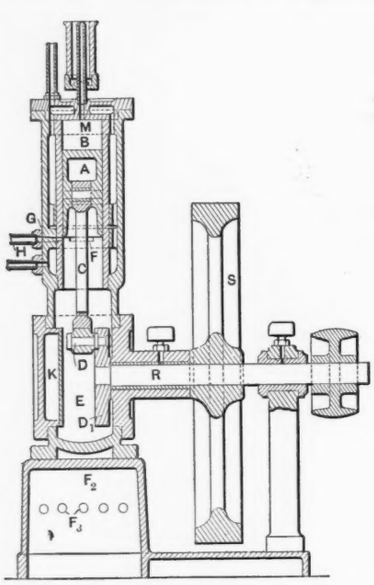


Fig. 6.

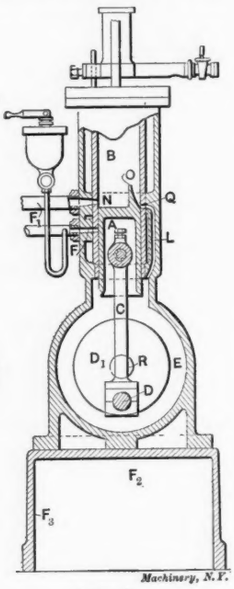


Fig. 7.

Cock Patent, August 6, 1895.

jority of the products of combustion escape, while previous to such exhaust a certain amount of compression has been given to the mixture of air and gas below in the chamber E in such manner that, as aforesaid, as soon as the exhaust has taken place the explosive mixture passes by the passage L_2, groove L_1, in the piston or plunger A, and by the other passage L_3 into the upper part of the cylinder. By this means I attain that the explosive mixture reaches the upper part of the cylinder and away from the exhaust-port, so that the incoming charge does not escape thereby and cause a waste.

By regulating the size of the exhaust-port orifice I am enabled to leave more or less of the products of combustion in the cylinder at the end of the downstroke, as desired. The cubical contents of the inclosed lower chamber, and the cylinder should bear such relation to one another that on the charge being delivered into the cylinder from the lower chamber E both sides of the plunger should be at or about atmospheric pressure. Lubrication of the working parts and the keeping cool of the same are attained by permitting one or more of such parts to move or impinge against oil or water, or a mixture of both, in the bottom of chamber E. The speed of the engine may be governed by means of any suitable governing device acting on the gas-supply or otherwise.

Patent of F. W. C. Cock, Figs. 6 and 7.

Fig. 6 is a sectional elevation with the piston or plunger at the top of its stroke, assuming the engine to be vertical; and Fig. 7 is an end elevation, partly in section, with the piston at the bottom of its stroke.

In the drawings, the admission of gas and air is shown as through two separate ports, the air being admitted by the port F, while the gas is admitted by the port G. These ports, it will be seen, are of considerable width, but of little depth, so that the duration of their opening will be brief, as they will be closed except when the piston is at or near the extreme of its return stroke. The flow of the gas and [or] air or of the explosive mixture may be controlled by any suitable device.

The following is a description of the mode of working this invention: Assuming the piston A to be at the top, as shown in Fig. 6, it will be seen that the air and gas ports are uncovered, and are now in free communication with the chamber E, in which, at this time, a partially-vacuous condition exists, and the air and gas rush in to satisfy this vacuous condition. At this moment, also, the explosive mixture is in a compressed state above the piston and is driven into the igniting-tube M, shown as placed in the top cover of the cylinder, which ignites it in the usual manner, producing the downward or "power" stroke. Almost immediately after the commencement of this downward stroke the gas and air ports are closed by the descent of the piston, which then begins to slightly compress the gas and air mixture, which has been drawn into the chamber E below it. By the time that the piston has completed its downward stroke, as shown in Fig. 7, it has uncovered the outlet-port N, thus allowing the products of combustion to escape, and it has also uncovered the upper mouth Q of the passage L forming the communication between the chamber E and the upper side of the piston. The products of combustion have, as regards the bulk of them, escaped through the exhaust by reason of their pressure above that of the external atmosphere, and as soon as this escape has lowered that pressure to the condition prevailing in the chamber E the mixture passes up the passage L into the upper part of the cylinder, coming in contact with the shield or deflector O, which is carried on the top of the piston. This shield or deflector prevents the passage of the mixture across the top of the piston and out by the outlet-port, and compels it to rise to the top of the cylinder, passing away from the exhaust-port, thus enabling it to sweep round and chase before it the small portion of the products of combustion remaining in the cylinder. By this time the piston has so far advanced in its upward stroke as to cover the mouth of the exhaust Q of the passage L. During the ascent of the piston, it will be seen that the before-mentioned partially-vacuous condition in the chamber E below it is produced. The cylinder is shown water-jacketed in the usual well-known manner.

Patent of Clark Sintz, Figs. 8, 9 and 10.

In the drawings a represents the cylinder, which is provided with an annular water-chamber surrounding the same, in the usual way; b, is the piston arranged therein, and connected by a pitman c, to the crank d, on the main shaft d_1, which shaft preferably extends through the lower portion of the main frame which supports the cylinder and turns in suitable bearings d_2, therein; said shaft being supplied with suitable fly or driving-wheels d_3. The piston b, is made of considerable length and chambered out so that the pitman c is connected thereto near the upper end or head thereof. Extending through the walls of the piston thus formed is an opening or port e.

Arranged in the side of the cylinder and opposite to the port e, of the piston, are exhaust and supply ports f, g, which ports are opened and closed successively and are never open to the cylinder at the same time, one or the other being constantly closed by the piston b; the exhaust port f, being adapted to open into the upper part of the cylinder just before the piston reaches the limit of its downward stroke, the supply port g, being adapted to communicate with the lower portion of the cylinder when the piston reaches the limit of its upward stroke. On the opposite side of the cylinder is a chamber h, formed in the walls of the cylinder, which communicates with the interior of the cylinder through ports h_1 h_2 which I will designate as the direct and indirect supply ports. The port h_1, is adapted to communicate with the upper end of the cylinder and above the piston, as the piston reaches the limit of its downward stroke, while the port e, which opens directly to the explosive chamber through the walls of the piston, communicates with the port h_2, at the same time,

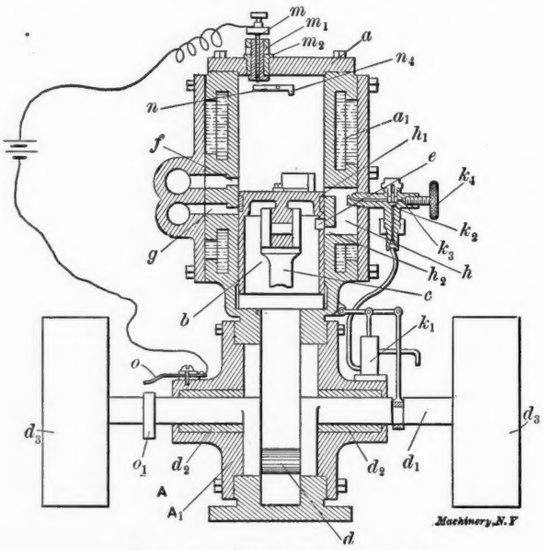


Fig. 8. Sintz Patent, November 21, 1893.

and thus establishes a communication from the lower end of the cylinder to the upper end of the cylinder through the chamber h, as the piston reaches the limit of its downward stroke.

The base of the engine A, which forms the main frame and supports the cylinder is preferably formed with a chamber A_1, which incloses the crank d, and which is completely closed by side plates which support the bearings d_2. This chamber A_1, preferably communicates directly with the lower end of the cylinder which is left open for this purpose.

Arranged on the top of the piston is a curved deflector j, which extends about half way around the said piston, concentric with the periphery of the piston and a slight distance therefrom, said deflector being turned outwardly at each end to form radial projections which approach in close proximity to the inner walls of the cylinder. This deflector stands opposite the port h_1, when said port is opened by the downward movement of the piston, and serves to deflect the air and gases admitted through said port to the cylinider, and causes them to rise upwardly and circulate around the top and sides of the cylinder when so admitted, in the manner hereinafter more fully described.

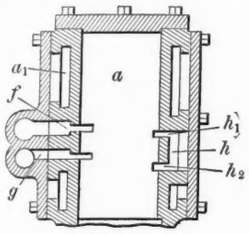


Fig. 9.

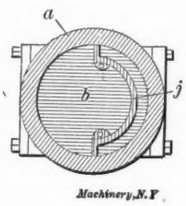


Fig. 10.

At one side of the cylinder and extending into the chamber h, is a supply valve k, through which the gasoline is upplied from a pump k_1, which may be operated from any suitable connection with the running parts of the engine. This supply or gasoline valve k, is provided with a check k_2, which permits the passage of the gasoline into the chamber h, but prevents any backward flow therefrom; it is also preferably provided with an outlet opening k_3, controlled by a valve k_4, by which the presence of the gasoline within the supply valve may be determined. From the check k_2, the gasoline passes directly into the chamber h, through a passage which is preferably inclined at the outer end, to give an upward and outward discharge to the gasoline in the direction of the port h_1.

The operation of the device as thus described is as follows: The piston being at the limit of its downward stroke, with the supply port g thus closed by said piston, motion is imparted to the shaft which causes the piston to ascend, thus forming a partial vacuum in the lower end of the cylinder and in the chamber A_1, connected thereto. This continues until the lower end of the piston passes the port g, when the air immediately rushes in to supply the partial vacuum thus formed. As the shaft continues to revolve the piston descends, thus compressing the air in the lower end of said cylinder and in the chamber connected thereto until the port e, comes opposite the port h_2, which occurs simultaneously with the opening of the port h_1, by the upper end of the piston. The air from the lower end of the cylinder, owing to the slight pressure thereon, caused by the downward stroke of the piston, rushes through the respective ports h_1, h_2, in the chamber h, into the cylinder, carrying with it a supply of gasolene, which is introduced through the supply valve at this point in the form of a spray and becomes thoroughly and intimately mixed and impregnated therewith. The port f has, by the downward movement of the piston, been opened, furnishing an exit opening, but the deflector j prevents a passage of the explosive mixture directly through the port f, and causes it to pass upward along the side of the cylinder to the top thereof, and, as the piston immediately begins its upward strok the exhaust port f is closed, and the charge thus introduced is compressed by the upward movement of the piston. Arranged in the top of the cylinder is an electric ignitor or exploder, which consists essentially of an electrode, m, preferably screw-threaded and adjustable through an insulated sleeve, m_1, arranged with a suitable screw-threaded supporting casing, m_2, which screws into the top of the cylinder. Arranged within the cylinder is an oscillating bar n, on the end of a rock-shaft n_1, which is supported in a suitable bearing in the side of the cylinder and is connected on the outside, through the medium of an arm n_2, to a spring n_3, this spring being so arranged that one extremity of the bar n, is held normally in contact with the electrode m. The opposite end of the bar n, is preferably provided with a lug or projection n_4, adapted, as the piston ascends, to come in contact with the top of said piston or with the deflector j, which is preferably employed in this instance for that purpose. This causes the bar n, to be withdrawn from the electrode and produces a spark at this point, just as the piston has reached the limit of its upward stroke, and just as the compression of the explosive charge has been completed. The result is: an explosion follows and the piston is driven downwardly until it passes the exhaust port f, when the products of combustion are discharged. This occurs just prior to the opening of the port h_1, by the piston, the lower end of the exhaust port f, being substantially on a line with the upper edge of the port h_1, so that the exhaust port is wide open at the time the supply port h_1, begins to open. The inrushing charge, which, by the aid of the deflector is given the upward and circulating motion, described, assists in driving out the products of combustion through the exhaust ports, these ports being momentarily open at the same time.

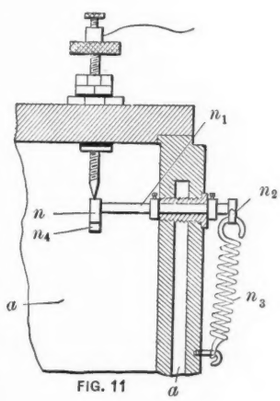


FIG. 11

In order to insure the rapid movement of the bar n, away from the electrode and thus the formation of the spark instantaneously, I preferably form the electric contact end of the bar n, considerably longer than the end which contacts with the piston, which causes it to move more rapidly than the shorter end. The electrode m, as before noted, is insulated from its supporting casing and thus from the other parts of the engine. The bar n, is not insulated so that the other electrical connection can be made to any of the metal portions of the engine. To provide for shutting off the battery, except just as it is required, and thus preventing its deterioration, I provide for automatically making and breaking the circuit before and after the spark is formed in the manner described. This I accomplish by connecting one pole of the battery to the electrode m, and the other to an insulated contact device o, secured in any suitable position to the engine and adapted to contact intermittently with one of the moving parts of the engine, so that a connection will be formed therewith just prior to the time that the spark is to be formed, the connection being broken as soon as the spark has been formed. This may be accomplished as shown in Fig. 8, by a cam or eccentric o_1, arranged on the main shaft and adapted to contact with the contact device, o, formed in the nature of a spring just before the spark is to be formed and to be withdrawn from contact therewith just after. The arrangement, however, can be modified, so that it may be applied to any portion of the engine and adapted to contact intermittently with any moving part.

Engine of S. M. Howell, Figs. 15 and 16.

From the above records of these inventions it is quite evident that the first half of the 90th decade marked a period of great activity among inventors of two-cycle engines. Who is entitled to the credit of originating the general features of the system, is a question which we must decide as best we may from the material at hand. Nash's two-cycle patent is the earliest formation of the general idea, and unless we could find earlier records in the patent office, we should therefore award to him the palm of priority.

There are, however, a number of minor points separately covered by these patents, and which may be determined by a study of the drawings, much more readily, indeed, than by reading the claims, which are largely a mass of conflicting testimony.

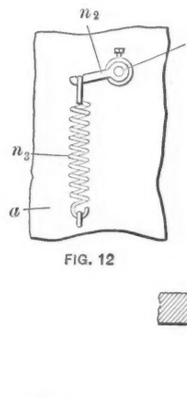


FIG. 12

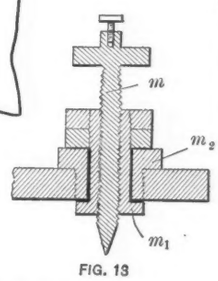


FIG. 13

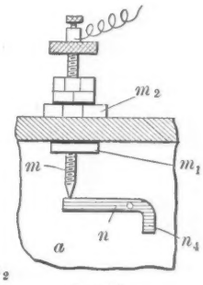


FIG. 14

Machinery, N.Y.

Details of Sintz Engine.

Figs. 15 and 16 show a two-cycle engine of simple construction, designed by the author. This style of construction has proved very reliable and efficient, either as a boat, automobile or stationary motor, and being of such varied adaptability may well be termed universal. The figures show this engine in a vertical position, but it may be placed horizontally or completely inverted. The latter position has been very successfully adopted by some automobile manufacturers. An engine thus placed requires but one oil cup. This is screwed into the top (or what would otherwise be the bottom) of the crank

case, and from this single point, sufficiently lubricates the entire mechanism, including the cylinder.

Figs. 17 and 18 with the accompanying specifications describe the Hain three-cylinder engine.

Hain Three-cylinder Engine, Figs. 17 and 18.

Fig. 17 is a longitudinal vertical section of a device embodying my invention, and Fig. 18 a plan view of the same with parts broken away to show the construction.

Like letters refer to like parts in both figures.

The device consists, essentially, of a series of base compression combustible-vapor engines, having a common crank-shaft,

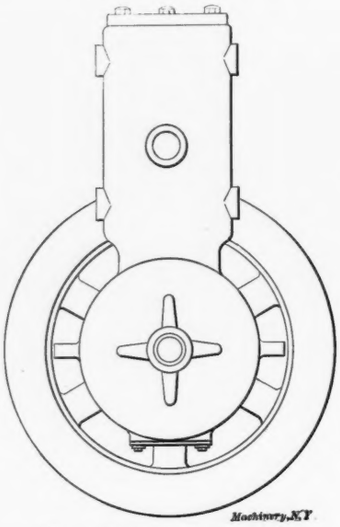


Fig. 15. End View of Howell Engine.

with cranks set at such relative angles that the engines act in succession, the charge in the first engine in the series being fired by the usual means and the other charges being fired in succession by the escape of a portion of the charge of the preceding engine through a suitable port connecting the various cylinders of the engines.

A A′ A″ are the cylinders.

B is the intake and firing port of the first cylinder, closed by a check *E* and provided with firing mechanism *D*.

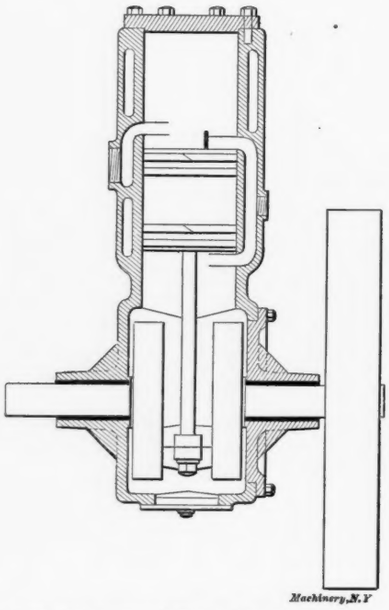


Fig. 16. Sectional View of Howell Engine.

B′, *B″* are passages from each base to the upper end of each cylinder, which passages are closed by checks *E″*. The series of cylinders is connected by ports *B″*, provided with checks *E′*. Each port opens into the cylinder first in series at such point that said port will be uncovered by the piston *N* in that cylinder when the piston in the next cylinder is at the beginning of its power stroke. This point will depend on the relative angle at which the cranks *L* are adjusted, which angle is preferably not more than sixty degrees. The other end of said port *B″* opens into the top of the next cylinder in the series. Each cylinder is provided with a piston *N*, connected by a rod *M* to one of the cranks *L* aforesaid. Each cylinder is also provided with an exhaust-port *C*, opened by the descent of the piston to exhaust the charge, and each base also has the usual intake *O* for the incoming charge.

Each check *E* is provided with a stop to hold the same closed, consisting of a screw *K*, adapted to be turned down on said check.

Relief-valves *F* are provided on each cylinder and base, except the first in the series. The one on the middle base is not shown in the drawings. Said valves are each held closed by a spring *I*, engaging a knob *J* on the valve-stem and held open by a pawl *G*, engaging a groove *H* in said stem.

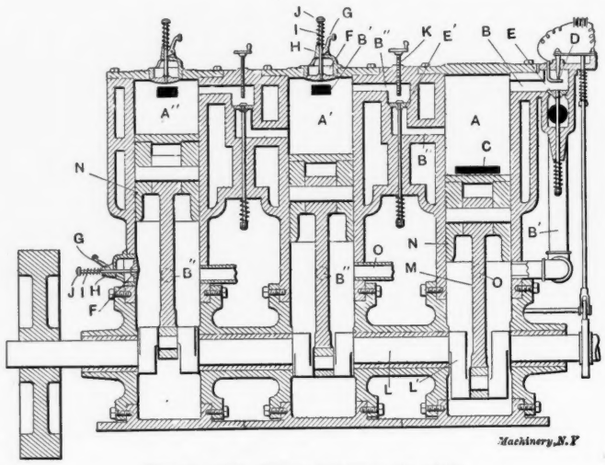


Fig. 17. Hain Patent, February 22, 1898.

The operation of the first engine in the series, when the check *E′* between it and the next one is closed and the relief-valves *F* are all open, is the same as a complete single-cylinder base compression-engine, the other pistons running idle and working air freely through the relief-valves *F*. By closing the relief-valves of the next cylinder and base and releasing the check *E* between it and the first cylinder this second cylinder will take charges through *O* and *B′* the same as the first cylinder. Said charges will be fired as the piston of the first cylinder descends and uncovers the port *B″* by a portion of the charge in the first cylinder escaping through said port. The third cylinder in the series can in like manner be brought into action by releasing its check-valve *E′* and closing its relief-valves *F F*. The drawings show but three cylinders; but it is evident that the series may be prolonged indefinitely. By

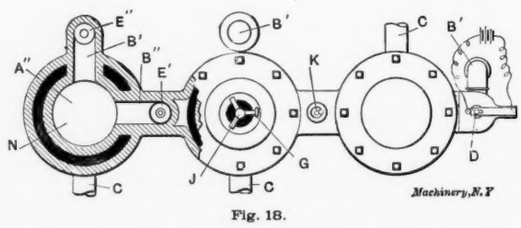


Fig. 18.

adding three more cylinders and placing the cranks at sixty degrees apart the cylinders would come into action in succession equidistant around the entire revolution of the shaft, thus making a very steady impulse. Any desired number of cylinders could be thus connected in series and operated as described. Also by the described construction engines of high power may be made that can be started into action in series, as described. By cutting out a part of the cylinders, as described, the power is more economically reduced than by reduced charges in a single large cylinder.

* * *

The 200th anniversary of the birth of Franklin was celebrated in some of the larger cities January 17. The scientific work of Franklin in establishing the identity of lightning and electricity is known perhaps as his greatest achievement. The courage required to make the famous kite experiment can scarcely be appreciated at this time. Not only was Franklin in some actual danger of death from lightning stroke but according to the notions of that time he was inviting it by tempting the wrath of the Almighty in doing something very sacrilegious.

WILLANS-PARSONS TURBINES.

In a recent number of MACHINERY was published a description of the new Allis-Chalmers steam turbine and details were shown of several important features, among them being the arrangement of the balancing pistons of the rotors, by which the thrust upon the steps of the drum is balanced.

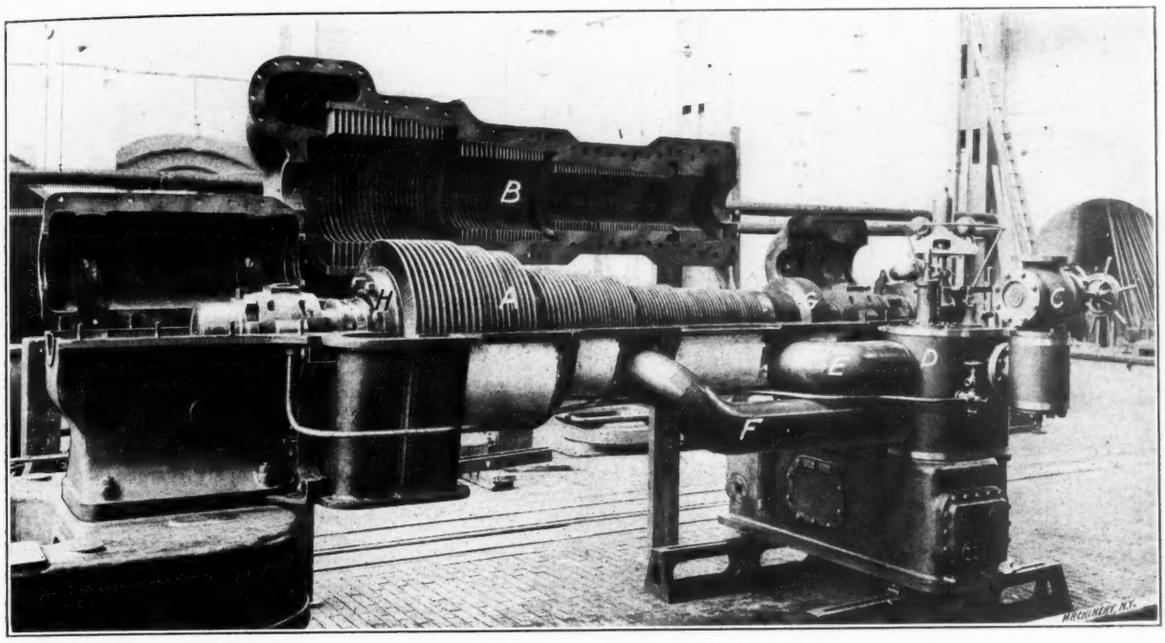


Fig. 1. One thousand H. P. Willans-Parsons Turbine.

We show in Fig. 1 a Willans-Parsons turbine, made by the well-known engine builders, Willans & Robinson, Rugby, England. Its design is similar to that adopted by the Allis-Chalmers Co., since both these firms are members of the Turbine Advisory Syndicate, controlling certain important patents upon the turbine. This illustration shows the construction more clearly than the illustrations of the article in the January number. Referring to the cut, *A* is the rotor and *B* the top of the casing removed to expose the rotor. Steam is admitted through the stop valve *C*, and within the casing at *D* are the valves controlling the admission of steam to both the high-pressure and low-pressure parts of the turbine. The high-pressure steam passes through *E*, but in case of an overload a by-pass valve opens and high-pressure steam is admitted through *F* to the low-pressure end of the rotor. It will be noted that there are no valves, piping or valve gear connected with the top of the casing, and that there is therefore none to be disconnected when it is desired to remove the top for examination.

The usual arrangement of the balance pistons in the Parsons turbine has been to have three of different diameters at the high-pressure end, the larger one balancing the thrust of the step at the low-pressure end of the drum. In the present arrangement, however, what correspond to the two smaller pistons only are at the high-pressure end and are shown at *G* in the engraving. The low-pressure piston is at

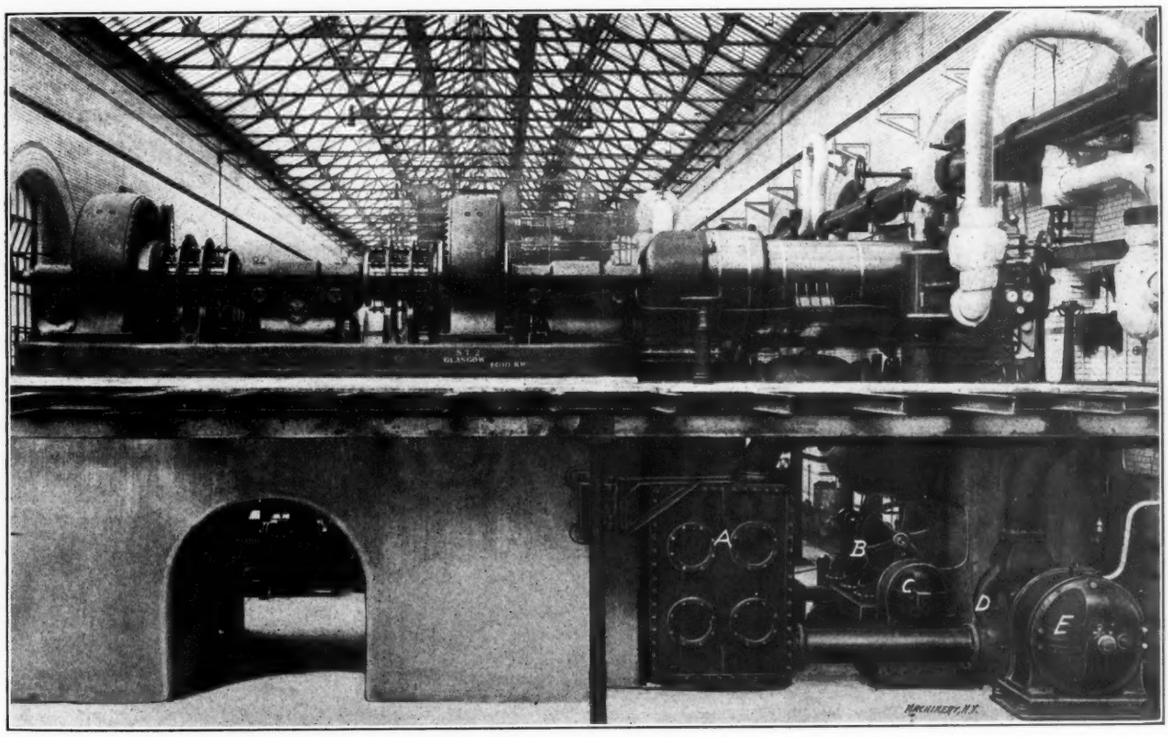


Fig. 2. Two thousand H. P. Willans-Parsons Turbine, Direct-connected to two 700 K.W. Generators.

H at the other end. This piston is so located that nearly its whole circular area is available to balance the thrust, whereas in the other form of construction only an annular area is available due to the difference between the diameters of the largest and next smaller size of piston.

Fig. 2 is a photograph of a 2,000 horse power Willans-Parsons turbine at Glasgow, Scotland, and is of interest because of the excellent view of the condensing apparatus used in connection with the turbine. The condensing equipment is compactly arranged and located in the pit or basement beneath the turbine. The surface condenser is at *A*. A triple-cylinder air pump, *B*, of the Edwards type is driven by the motor *C*, and *D* is a centrifugal circulating pump driven by the motor *E*. This equipment is a model in compactness and simplicity of arrangement, compared with many condenser outfits that have been supplied with turbines in this country.

* * *

EARLY BUILDINGS OF THE SKELETON TYPE.

HOWARD A. COOMBS.

I noticed in your August number a statement that the Tower Building on Broadway, New York, was soon to be demolished in order to make room for a new building, and that the said building was the first of the skeleton construction buildings ever erected.

This belief, which is not warranted by the facts, is doubtless owing to the presence of a bronze tablet affixed to the walls of the Tower Building, and purporting to be in commemoration of its being the pioneer of the modern type of office-building construction. The tablet was placed on the building in question in August, 1899, by the Society of Architectural Manufacturers, a New York organization. The society seemed to have relied upon a real estate publication called the *Record and Guide* as proof that the Tower Building was the first skeleton building ever constructed. However, Mr. Bradford L. Gilbert, the architect of the Tower Building was not the originator of the skeleton construction.

The Home Life Insurance Company's Building in Chicago, which was built in 1883-4, was the first example of the skeleton construction and to its architect, W. L. B. Jenney, belongs the honor of being the first to actually construct a tall office building in that way.

A controversy, or rather discussion, for the conclusions were almost unanimous, as to who was the inventor or originator of this type of building, was started in the *Engineering Record* for June 27, 1896, by a letter from F. P. Gates, president of the Bessemer Steamship Company, to the editor, which read as follows:

"Sir: Will you have the kindness to inform me to what architect or engineer the honor is due of discovering and practically working out the idea of lofty steel construction of buildings."

The purpose of this inquiry was to honor the said architect or engineer by naming one of the steamers of the company after him.

In reply a number of contributions were received from prominent architects and engineers and the consensus of opinion awarded priority to Mr. Jenney, and the Home Life Building. However, the said building was not a complete example of what is known as skeleton or veneer construction, as cast-iron columns were used in the main piers, the latter being self-supporting and not carried by the columns. The fact, however, that Mr. Jenney supported the walls and floors of each story independently on the said columns, thus dividing the total movement, due to expansion and contraction, into as many parts as there were stories, entitled the building to be called the first example of modern office building construction.

The second building in which the skeleton construction was used was the Tacoma Building, Chicago, Holabird & Roche, architects. This building was of skeleton construction throughout, the entire outer walls, as well as the floors, being carried by the frame.

An early instance of partial skeleton construction was the New York Produce Exchange Building, erected by George B. Post in 1881, in which the interior courtyard wall was constructed with a cage of cast-iron columns and wrought iron girders, filled with brick panels. A similar construction was used in the court of the Rookery, Chicago, Burnham & Root, architects, 1885-6.

If fragmentary or partial examples are to be considered, we must go even further back than 1881. There is a short tower at 82 Beekman Street, New York, projecting four stories above a three-story building, in which the panels or walls are carried by the framing, which was built about the middle of the last century.

The Broad Street Station of the Pennsylvania R. R. in Philadelphia, erected in 1881-2, had wrought iron columns from the ground floor upward, encased in masonry carrying a second floor, then extending to the third floor and carrying plate girders, on which was built the upper part of the rear exterior wall of the building.

Abroad we have the Printemps store in Paris, built in 1883-4, in which the floors are carried by wrought iron columns, while the outside walls are self-supporting, and the Crystal palace, London, first constructed for the exposition of 1851, in which the walls are of glass carried by the frame-work.

Architect L. S. Buffington, of Minneapolis, claims to be the first inventor and discoverer of skeleton construction. He took out a patent May 22, 1888, which discloses a form of skeleton and veneer construction applied to tall buildings. It is remarkable that, notwithstanding his patent and claim to be the originator—in a letter to the *Engineering Record*, published August 8, 1896, he says the Boston Block in Minneapolis, built in 1881, has a skeleton frame—his name is not even mentioned by any of the other architects who discussed the matter about that time in the said journal.

The writer understands that Mr. Buffington's patent has been acquired by a syndicate and that a number of suits against the owners of buildings were filed shortly before the patent expired last May. That being so, the whole subject is likely to be thrashed out in the courts and the decisions will make interesting reading for those who are interested in the subject.

* * *

The following results secured in a number of boiler plants recently equipped with economizers by the B. F. Sturtevant Co., Boston, Mass., are suggestive of the possibilities in the way of increasing the temperature of feed water and the boiler output without additional expenditure of fuel. Manifestly, such results are equivalent to maintaining the initial boiler output with a decreased amount of fuel.

Plants Tested.	Gases Entering Econ. Degrees.	Gases Leaving Econ. Degrees.	Water Entering Econ. Degrees.	Water Leaving Econ. Degrees.	Gain in Temperature of Water. Degrees.
1	650	275	180	340	160
2	575	290	160	320	160
3	470	230	130	260	130
4	500	240	110	230	120
5	460	200	90	230	140
6	440	220	120	236	116
7	525	225	180	320	140

It is to be noted in this connection that an economizer is capable of producing the best results in connection with a mechanical draft plant. The objection always raised against the economizer is that it reduces the temperature of the gases so much that they are not efficient in maintaining an unbalanced pressure in the chimney, and the draft consequently suffers. With mechanical draft, however, this objection is removed, since the degree of draft is entirely independent of the chimney temperature.

* * *

One of the most beautiful applications of the thermit welding process is that of pipe welding, but it is only recently that any important commercial application of the process was made in this country. The Manhattan Refrigerating Co. in New York City employed it to weld pipes that were laid in the ground on Fourteenth Street; these were used as service return pipes in the delivery of liquid ammonia at 180 pounds pressure which was conveyed to various cold storage warehouses on the street. Twenty-nine 1¼-inch and twenty-seven 2-inch joints were welded. The pipe was first welded into lengths varying from 40 to 100 feet and then rolled into the ditch and there welded into the line, thus making the pipe line one continuous pipe without fitted joints, and the two-inch pipe had only one expansion bend.

VARIABLE SPEED MECHANISMS.—8.

GEARED DEVICES (Continued).

In Fig. 71 is shown gearing for transforming speed which was patented by R. H. F. and A. H. Finlay, February 6, 1900, No. 642,594. This appears to have been designed with reference to the requirements of hoisting apparatus and such use is mentioned in connection with the apparatus. *A* is described as a high-speed shaft carrying two pinions, *B* and B_1, which are of the same pitch diameters and are mounted solidly on the shaft. These pinions drive two nests of gears, *D E C* and $D_1 E_1 C_1$, also *d* and d_1. *D* and *d* are both of the same pitch diameters. The cones of gears are mounted in two disks, *G* and G_1, which are free to rotate on shaft *A*. The gears mesh respectively with the internal gears $H H_1 H_2$. These internal gears have extended hubs on which are the drums $I I_1 I_2$. Ro-

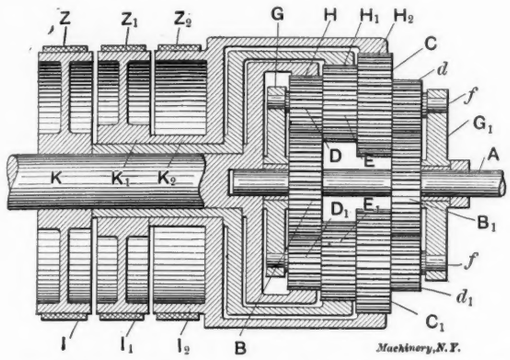


Fig. 71. Differential Device of R. H. F. and A. H. Finlay, Patent No. 642,594 February 6, 1900.

tary motion communicated by shaft *A* to the two cones of gears causes them to rotate at a slower rate and gives them epicyclic motion traveling around with the frames or disks *G* and G_1. If there were only one pinion meshing with an internal gear constructed in this manner no motion would be communicated to the internal gear, but since there are three internal gears meshing with pinions of different diameters it follows that there must be a relative movement between them. This fact is the basis of the claim of the invention. In order to make the apparatus convey power it is necessary to restrain one of the internal gears and this is done by applying one of the brake bands $Z Z_1 Z_2$ to the drums $I I_1 I_2$ respectively. If brake *Z* be tightened on the drum sufficiently to hold it, the gears *D* will travel around within the fixed internal gear *H* and motion will be communicated to internal gears $H H_1 H_2$ and in a direction opposite to the direction of motion of shaft *A*. If the brake Z_1 be applied the gear *H* will then run in the same direction as the shaft while the gear H_2 will move in the opposite direction but at a further reduced speed; and if brake Z_2 be applied then both gears *H* and H_1 will move in the same direction of the shaft *A* but at different speeds. The relative position of the drums $I I_1 I_2$ need not of course be as shown in the cut and the method of application of the brake bands need not be as illustrated but may be varied so that motion may be taken off as the application of the piece may suggest. For example, for hoisting purposes it is suggested that the drum for the lifting chain might be rigidly attached to K_1 in which position it could be made to revolve in either direction or stopped by the application of the brakes. While this device is not properly a speed varying mechanism *per se* it does have certain suggestive features inasmuch as it is possible to use a multiplicity of gears. It, however, is open to the serious fault of most epicyclic trains and that is inefficiency, caused by friction losses.

The variable speed mechanism shown in Fig. 72 was patented December 11, 1900. The patent No. 663,442 was granted to M. C. Johnson and the invention is designed more particularly for the requirements of automobiles and for this reason contains a reversible feature which is not a necessary function of all variable speed devices and, therefore, need not be considered in this connection. Three gears *J*, *K* and *L* are mounted on shaft *M* and meshing with them on the parallel shaft *A* are the gears *C*, *D* and *E*. These latter gears are controlled by clutches *F* and *G* by which any one of the three may be made fast to *A* and to revolve with it, thereby giving three distinct speed changes. The means by which the changes are effected by the simple movement of a hand lever is illustrated in the elevation cut, cams being mounted on shaft *S* which operate the levers *P* and P_1. The cams are so pitched that the speeds follow in progression and there can be no locking of gears since it is necessary to free one gear before the next gear can be engaged.

The variable speed gearing shown in Fig. 73 was patented by L. Jones, Jr., April 23, 1901, patent No. 672,779. It is of the type used on automobiles having two or more speed changes which are effected by tightening and loosening brake bands encircling drums. These brake drums are indicated at $A_1 B_1 C_1$. The drum A_1 is solidly mounted on shaft *A*. Adjacent to it is a clutch collar controlled by lever *P*. The shape of this clutch collar is such that the clutches controlled by arms C_1 are successively applied as the clutch collar is moved to the right. Loosely mounted on shaft *A* are three gears *B*, *C* and *D*. Meshing with these gears are the two sets of gears, *H*, *G* and *I*. These latter are mounted in the frame *F*, which is integral with drum A_1. The shaft *A* rotates continuously at uniform speed in the direction of the arrow shown thereon, and when the gear *B* is secured to the shaft *A* it drives the gear *G* in a direction, of course, opposed to the arrow. Said gear *G* is annular, and its inner circumference is opposed to friction-pawls at *e*, which are mounted for oscillation in the hub *E* of the spindle and pressed into engagement with said gear *G* by springs. Rotation of the spindles in this direction tends to progress them and the drum *F* in the same direction, and to prevent such progression, pawls are provided on the side of the drums which engage in the stationary ratchet *L*. Therefore, when the gear *B* is secured to the shaft *A* as the driving medium, the spindles being prevented from progression, the sleeve D_1 is rotated, in the direction of the arrow marked thereon, at a rate of speed which is much slower than that of the shaft *A* and determined by the ratio of the engaged gears

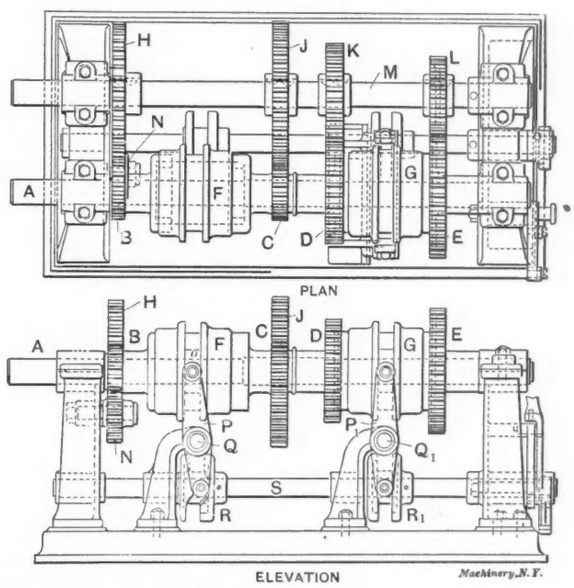


Fig 72. Patent No. 663,442, granted to M. C. Johnson, December 11, 1900.

B G and *I D*. During the rotation of the sleeve at the slow speed the planetary gears *H J* respectively rotate the gears *C* and *k* idly in the same direction as said shaft and sleeve. When it is desired to rotate said sleeve at the medium speed, the gear *C* is secured to the shaft *A* as the driving medium, and the planetary-gear spindles *E* are rotated more rapidly by reason of the difference in ratio between the engaged gears *C H* and now idle gears *B G*, so that the hub and the pawls slip forward with respect to the gear *G* without engaging the latter, and the sleeve D_1 is rotated by the engaged gears *I* and *D*. During the operation of the device at medium speed the brake-drum *K* is idly rotated. When it is desired to drive the sleeve *D* at the highest speed, the drum *F* is secured in fixed relation to shaft *A* as the driving medium and the sleeve D_1,

being held by the fixed relation with the shaft, rotates at the same speed as the latter. Except when locked as just described, the drum *F* has a tendency to rotate backward and is only prevented from thus rotating by the engagement of the pawls in the stationary ratchet *L*. Therefore, if the drum *F* is freed from the ratchet *L*, and the brake-drum *K*, which normally rotates idly in the direction of rotation of the shaft *A*, is prevented from rotating, the progression of the planetary gears *J* around the gear *k* of said brake reverses the drum *F* at a

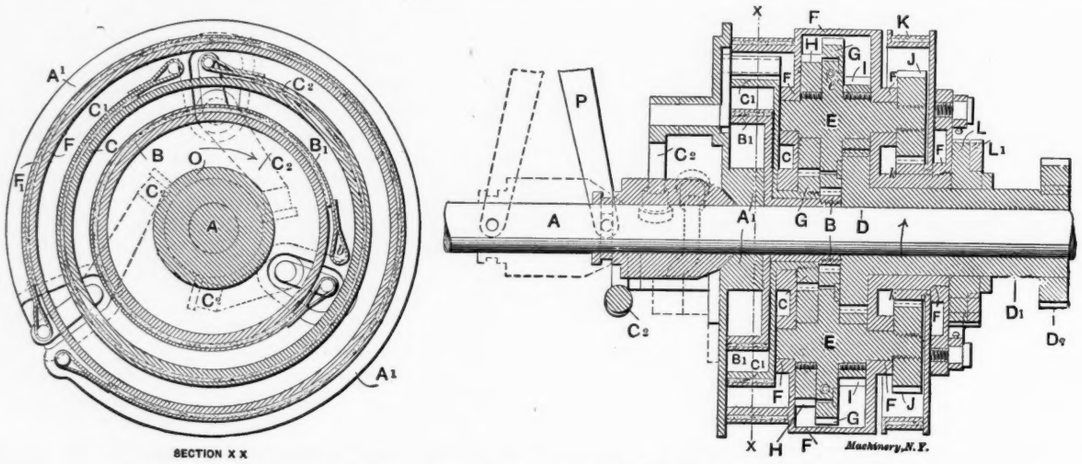


Fig. 73. Variable Speed and Reversing Mechanism. Patented by L. Jones, Jr., April 23, 1901, No. 672,779.

speed greater than the speed of rotation of the sleeve D_1 in which the result that the direction of rotation of the sleeve D_1 is reversed with respect to the direction of rotation of the shaft *A*.

The changeable speed gearing shown in Fig. 74 was patented by John E. Sweet, September 10, 1901, patent No. 682,507. It is of the type having two cones of gears, one of which cones is provided with a sliding key by which each individual gear of the cone may be successively made fast to the driving shaft. In this invention the keys are made in duplicate, being indicated at *P P'*. They are pivotally mounted and wards are provided between adjacent gears so that when moved from engagement with one gear to engage the next the keys move radially inward out of engagement with the first gear and then spring into place to the keyways of the adjacent gear. The wards referred to are washers indicated by *w* and the operating handle is shown at *E*. By this construction the keys or splines must be entirely out of engagement with one gear before they are engaged with another. Moreover the operation of changing from one speed to another while in motion is facilitated inasmuch as the pressure required to disengage the keys radially with the construction indicated in the cut must

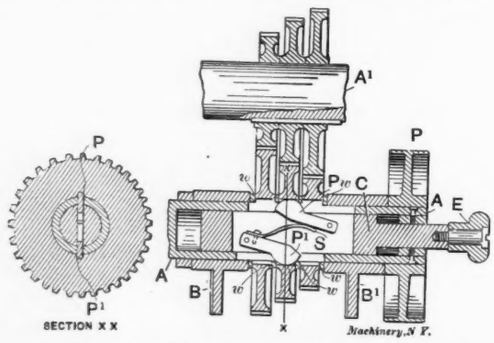


Fig. 74. Patent No. 682,507, granted to John E. Sweet, Sept. 10, 1901

be somewhat less than is required when they are moved longitudinally as in the usual construction of this type. The double key or spline is simply for the purpose of giving greater strength and to balance the thrust of the gear against the shaft, thus making changes from one speed to another still easier than is possible with only one.

Fig. 75 shows the change speed gear patented by A. Soames and W. Landon-Davies, November 22, 1904, patent No. 775,508. This invention is of the type having two parallel shafts on which are mounted gears of varying dimensions so arranged that only one pair of gears can be in mesh at the same time. Engagement with other pairs is effected by shifting one shaft longitudinally with respect to the other. In the drawing of the motor the continuous shaft is shown at *A*, being connected to the flywheel by clutch *C*. The driven shaft is shown at *B* and on it are mounted the gears *I*, *J* and *K*. Matching with these gears are gears *E*, *F* and *G* mounted on the sleeve *H*. This device, which is intended for changing the speed on automobiles, is so constructed that the mechanism must be disengaged from the source of power before change of speed can be effected. The foot lever *T* must be depressed to disengage the clutch *C* before the latch *Q* can be raised. This motion also disengages the square jaw clutch *N* at the same time. Then the sleeve carrying gears *I*, *J* and *K* may be moved longitudinally so as to engage other pairs of gears to effect the desired speed change. The reason for using the positive

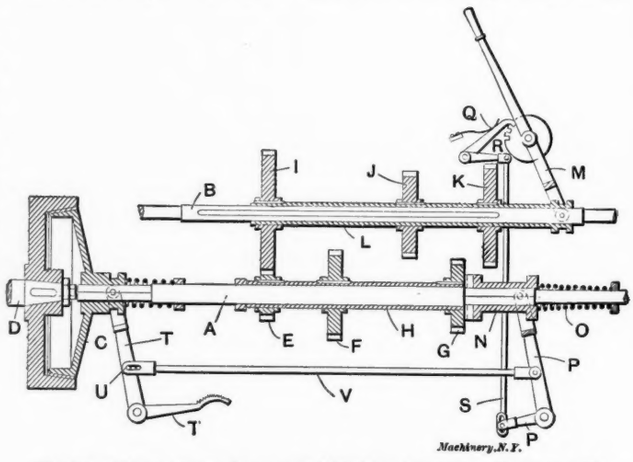


Fig. 75. Patented by A. Soames and W. Langdon-Davies, November 22, 1904, Patent No. 775,508.

clutch *N* is that by its use the friction clutch may be entirely disengaged from the sleeve *H* carrying the change gears and thus the inertia reduced to a low amount when engaging a fresh pair of gears. After the gears are engaged the positive clutch makes the sleeve fast to the shaft *A* and then further movement of the foot lever *T* throws the friction clutch into engagement with the engine. It is of course apparent that the weight and the diameter of the positive clutch may be made much less than that of the friction clutch which is a very important consideration with speeds of six or eight hundred revolutions per minute.

* * *

One of the interesting exhibits of the Watervliet Arsenal is a full-size wooden model of the huge 16-inch gun, model 1895, which was built for the defense of New York Harbor. This great gun, which bids fair to be the only one of its kind ever to be constructed in this country, has not as yet been mounted, although it is eleven years since its construction was started.

COMPLETE SCHEME FOR TURRET LATHE FIXTURE WITH SPECIAL SET OF TOOLS.

C. V. RAPER.

The samples *A*, *C*, *D* and *F*, to be machined, had to be interchangeable and made to gages of .001 inch limits. Fig. 1 shows the four samples of finished work, the rough castings *C* and *D* having parallel portions cast, as shown by the dotted lines marked "parallel." This was to save a set of special jaws for the Whiton chuck. The following "operation and tool list" explains the method of tackling each part and may serve as an example of how such special tools are gone into. Such a list is sent to the customer by the firm who supplies the turret lathes on receipt of an inquiry, together with blue print of samples. The customer's works manager or department head then goes through the list and strikes out any tool he considers unnecessary. There are always a few of them wedged in, so a careful examination usually repays itself, but the inquiry should be conducted by a capable man, understanding the system.

The tools in the list following, which have a "star" attached, were considered to rank among the superfluous lot by a certain draftsman who had the overseeing of the job, and it would be interesting to hear what other readers think of his "weeding."

Did he take out too many or too few?

Anyway, presuming that the selection of tools has been performed and the order placed, the next thing the customer does is to send, say, one dozen or so of rough castings of each of the pieces under consideration, and either he or his representative journeys forth (on receipt of communication) to see that the estimate time limits are bona fide.

Usually the time is quite a lot under that first stated, often as much as 20 per cent, and sometimes it is the other way.

Again, when a man in the "home" shop gets fairly used to the job, there can be a further per cent deducted till you get your premium price data fixed for that job.

Referring to the illustration showing the cutters, it will be seen that "A. W." steel and the Magic brand are both employed for some of the cutters. Comment on the advisability of special steels for certain classes of cutter would be valuable. "A. W." steel seems to top the list for lathe "bar tools" roughing, in a recently published tabulation of Dr. Nicholson's Manchester tests. Anent this, I notice that Messrs. Vickers, Sons & Maxim "withdrew" from the contest very early in the game. Why was this, I wonder? Is it possible that the "show" was not run quite fairly?

However, it is not very wonderful that the manufacturers of "A. W." steel should come out on top with a lathe of their own supplying, worked by (or at least "watched over" by) one of their own operators, while the other brands of steel stood absolutely on their merits. I am off the track now, but while getting back I'd just like to say that I hold no brief for, nor shares in, any concern making high-speed steel.

The operation and tool list for the before-mentioned samples is as follows:

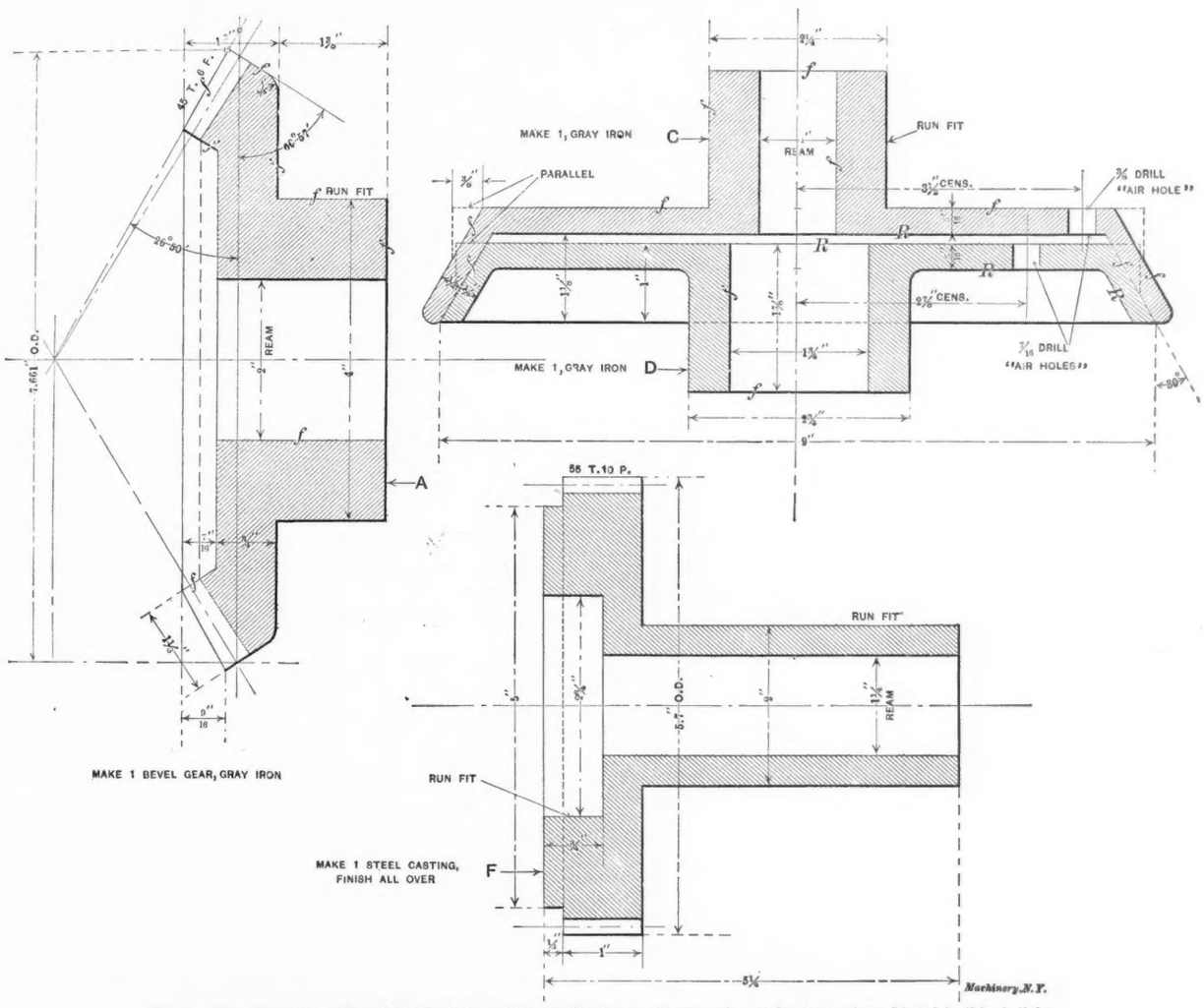


Fig. 1. Four Samples of Finished Work for which the Tools are Illustrated and the Operations Listed in this Article.

SAMPLE A.—Make from Iron Castings.

Hold by taper portion in special jaws in three-jaw chuck.

Rough bore with boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

*Finish ditto.

Bore to size with single-point boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

Ream with adjustable reamer held in floating holder bolted to face of turret.

Support on revolving steady peg held in holder bolted to face of turret.

Rough turn and face boss and flange with tool held in square turret.

Finish ditto.

After a quantity have been finished in the above manner, turn end for end.

Hold by flange in soft jaws in three-jaw chuck.

Rough face flange, and rough face end of boss with tool held in square turret.

One bush for revolving steady peg.

One set of soft jaws for three-jaw chuck.

*One radius form tool.

SAMPLES C AND D.

These were handled as follows:

Make from iron castings with a short portion of the outside diameter cast parallel to facilitate chucking.

Hold by parallel portion in three-jaw chuck.

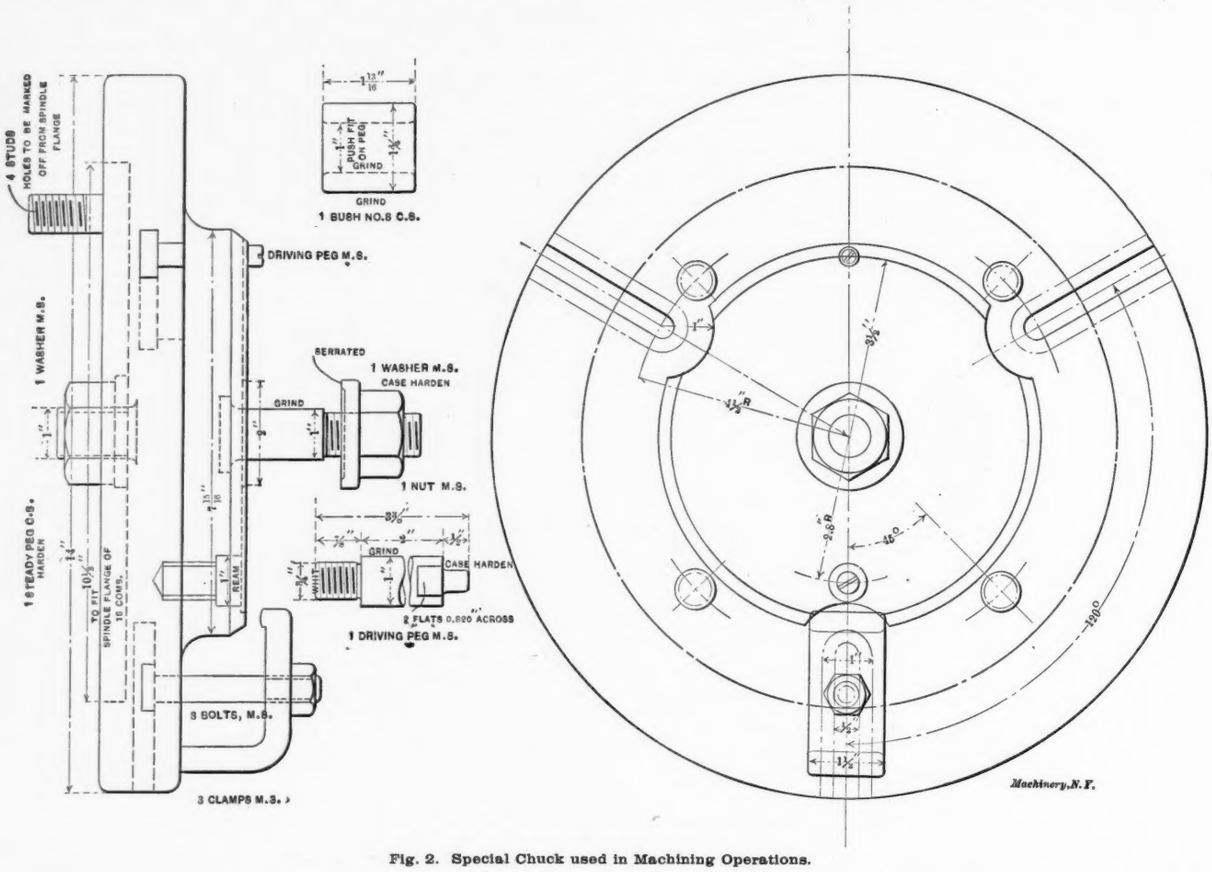
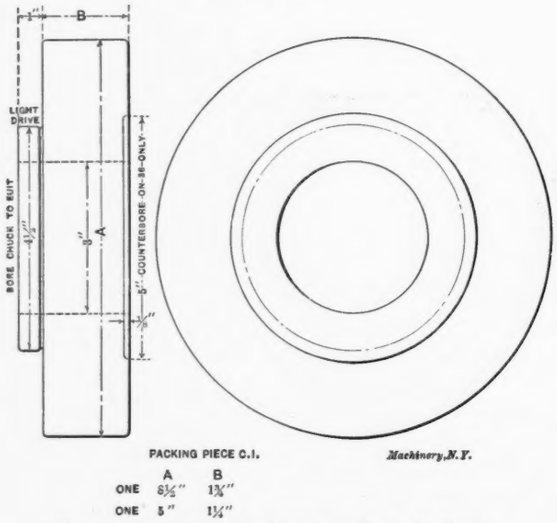


Fig. 2. Special Chuck used in Machining Operations.

Finish ditto.

*Form radius on end of boss with tool held in square turret.

Guaranteed time each, 1¾ hour.



	A	B
ONE	8½"	1¾"
ONE	5"	1¼"

Fig. 3. Packing Piece used in Connection with Chuck.

Tools Required.

One set of special jaws for three-jaw chuck.

One cutter for rough boring bar.

*One cutter for finish boring bar.

One adjustable reamer.

Rough bore with tool held in holder bolted to face of turret.

Finish ditto.

Ream with adjustable reamer held in floating holder bolted to face of turret.

Rough bore taper and rough face web with tools held in square turret.

Finish face web with tool held in square turret.

Finish bore taper and face end with combination boring, turning, and facing tool bolted to face of turret, and supported in steady bush fitted to chuck.

After a quantity have been finished in the above manner, we recommend that two air holes be drilled, which would allow the air to escape when the clutch is forced into position. They would also be used for clamping the sample against the fixture, after which the operations would proceed as follows:

Hold on special plate fixture, locating the finished hole of sample on a hardened steel peg, and clamping by the boss, a peg being fitted into the fixture opposite one of the air holes to act as a driver.

Rough turn taper portion on outside, rough face web, and rough turn boss with tool held in square turret.

Finish ditto.

*Form taper portion on outside with tool held in square turret.

Remove clamp from boss, and clamp through the air holes.

Rough and finish face end of boss with tools held in square turret.

Guaranteed time of each: Sample *C*, 1¾ hour; sample *D*, 1¼ hour.

Tools Required.

Two rough boring tools.

Two finish boring tools.

One adjustable reamer and floating holder.
*One extra adjustable reamer.
One rough boring tool for square turret.
One rough turning and facing tool.
One finish ditto.
One combination boring, turning and facing tool, fitted with a steady peg and set of cutters.
One steady bush fitted to chuck.

turret, and supported in steady bush fitted to chuck, and at the same time rough turn and face short boss and rough turn large diameter with tool held in square turret.

*Finish bore with boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

Bore to size with single-point boring bar held in holder bolted to face of turret, and supported in steady bush fitted to chuck.

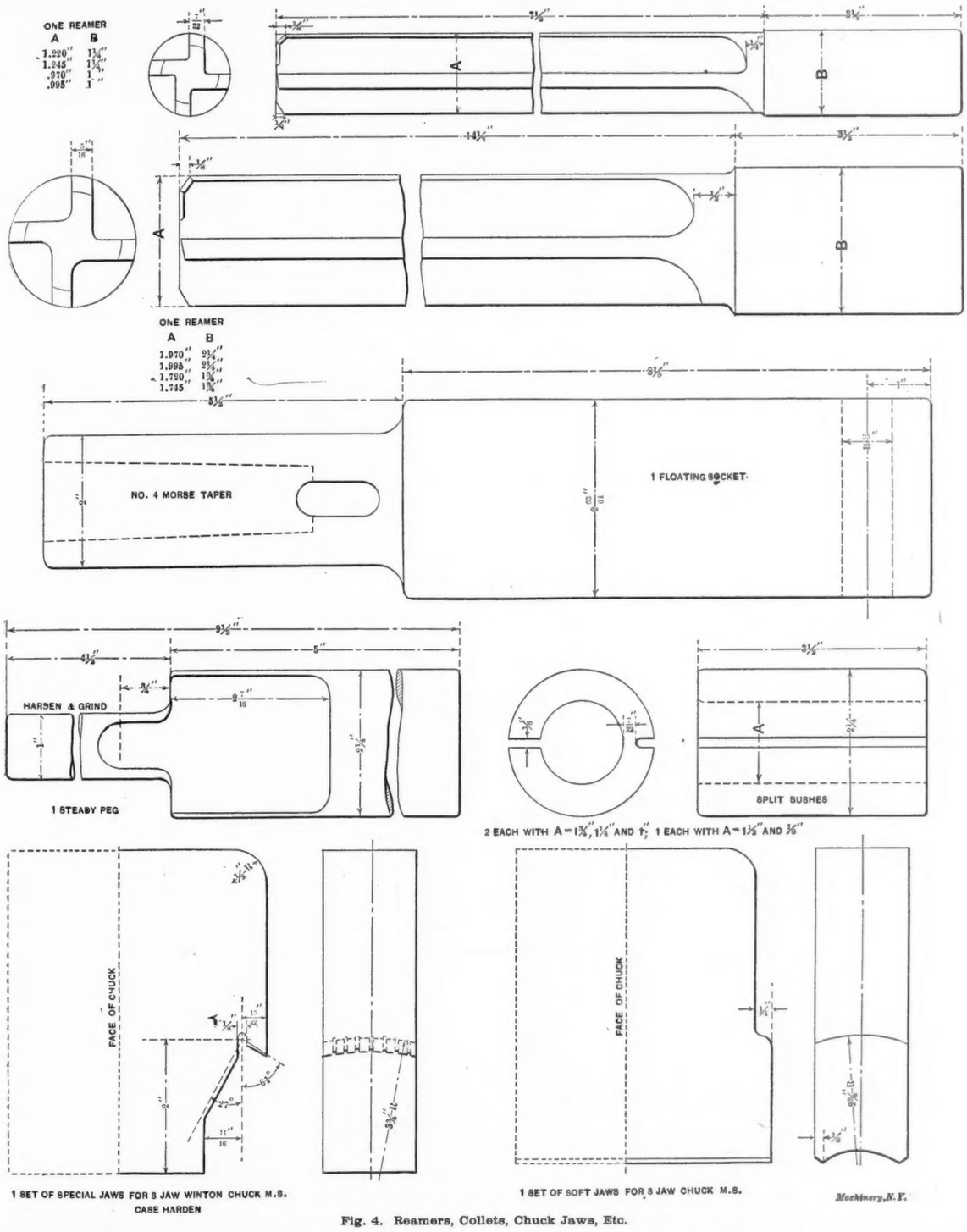


Fig. 4. Reamers, Collets, Chuck Jaws, Etc.

One special plate fixture, with two sets of clamp plates.
*One extra steady peg for same.
One steady bush fitted to chuck.
*One form tool.
Two boring bar holders.

SAMPLE F.—Make from Steel Castings.

Hold by long boss in three-jaw chuck.
Rough bore with boring bar held in holder bolted to face of

Ream with adjustable reamer held in floating holder bolted to face of turret.

Support on revolving steady peg held in holder bolted to face of turret.

Finish turn and face short boss and finish turn over top of large diameter with tool held in square turret.

After a quantity have been finished in the above manner, turn end for end.

Hold by short boss in soft jaws in three-jaw chuck.

Support on revolving steady peg held in holder bolted to face of turret.

Rough turn and face long boss with tool held in square turret.

Finish ditto.

Guaranteed time each, 2¼ hours.

One steady bush fitted to chuck.
One revolving steady peg.
One rough turning and facing tool.
One finish ditto.
One set of soft jaws for three-jaw chuck.
*Two boring bar holders. (One only.)

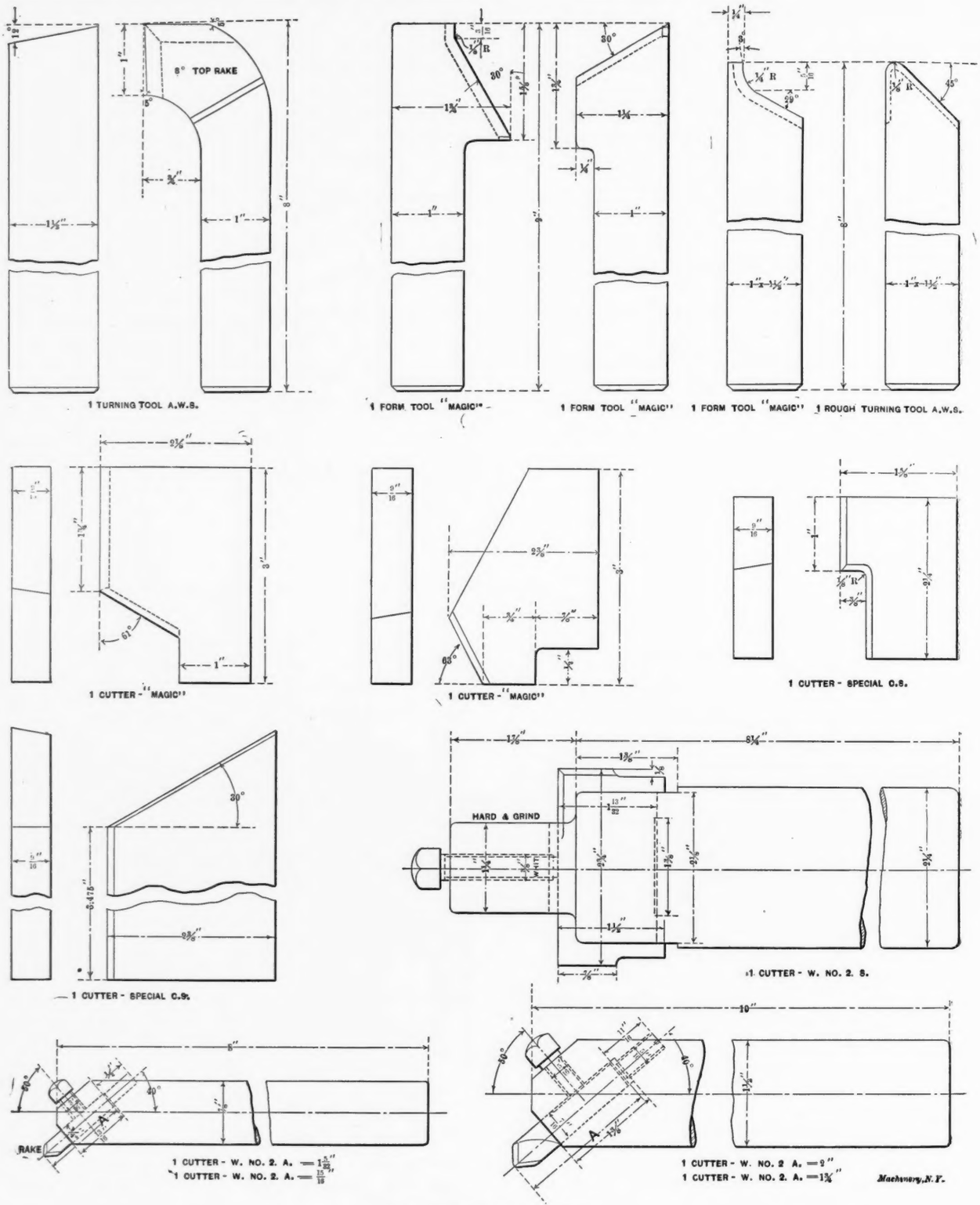

8° TOP RAKE
1 TURNING TOOL A.W.S.
1 FORM TOOL "MAGIC"
1 FORM TOOL "MAGIC"
1 FORM TOOL "MAGIC"
1 ROUGH TURNING TOOL A.W.S.
1 CUTTER - "MAGIC"
1 CUTTER - "MAGIC"
1 CUTTER - SPECIAL C.S.
HARD & GRIND
1 CUTTER - W. NO. 2. S.
1 CUTTER - SPECIAL C.S.
RAKE
1 CUTTER - W. NO. 2. A. — 1 5/32"
1 CUTTER - W. NO. 2. A. — 15/16"
1 CUTTER - W. NO. 2 A. — 2"
1 CUTTER - W. NO. 2. A. — 1¾"
Machinery, N.Y.

Fig. 5. Group of Cutters and Tools.

Tools Required.

One rough boring bar and cutter.
*One finish boring bar and cutter.
One single-point boring bar and cutter.
One adjustable reamer.

I might say here that the "air holes" referred to were spoken of as it was thought that the two pieces *C* and *D* were a disengaging clutch. However, the pieces eventually had oil holes drilled in them, so that this became unnecessary. It would be, of course, natural for some people to mistake this

type of non-positive feed drive for a (badly-designed) clutch. The fixture for holding both samples *C* and *D* is shown complete in Fig. 2 and is perfectly self-explanatory.

Lastly, will some readers give their opinions, as to what the cost of this outfit should have been? Perhaps it will surprise some when I say that it footed up to nearly £90 ($450) on the invoice.

* * *

WINDING OF DIRECT-CURRENT ARMATURES.*

A detailed description, given by an actual workman, of the various operations performed by an armature winder, accompanied by precise directions and data is not without unusual interest. The types of armatures to which this description apply are those used in direct-current railway motors, crane and hoisting motors, vehicle motors, bipolar motors and belted generators up to 100-kilowatt capacity.

Tools.

The tools used by an armature winder are as follows:

1 shoe knife,
1 pair seven-inch shears,
1 pair eight-inch pliers,
1 ten-inch screw-driver,
1 three-pound rawhide mallet,
1 small steel riveting hammer,
1 wedging tool (See Fig. 1),
1 heavy steel drift (See Fig. 2);
Also an assortment of fiber drifts of varying width, length and thickness (See Fig. 3).

The rawhide mallet is used in driving the coils into the slots by means of the fiber drifts, and in bending the coils into shape. The steel hammer is used for straightening laminations or finger plates. It should never be used in bending coils or on any of the drifts. The wedging tool made from a cold chisel, is used in driving wedges into the slots as a hammer would injure the insulation of the coils and might bend the laminations.

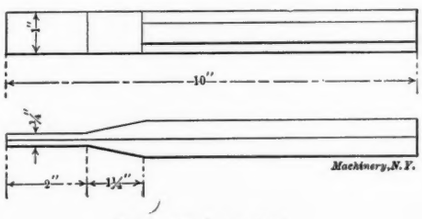


Fig. 1. Wedging Tool.

Core.—An armature core is built up of soft sheet steel laminations. These are stamped of the desired shape and carefully annealed. The stampings are then built up, and keyed to a shaft or spider and held securely in place by end plates. Ventilating spaces are left next the shaft or spider and air ducts are distributed at intervals through the punchings by putting in spreaders to hold the laminations apart. The armature in rotating draws in air through the ventilating spaces next the shaft and forces it out through the ducts, thus furnishing a simple and effective means of ventilation. After the core is assembled, the slots are filed to remove any projecting burrs—if these were not removed the insulation of the coil might be torn when a coil is driven into the slot and cause grounds and short circuits in the winding.

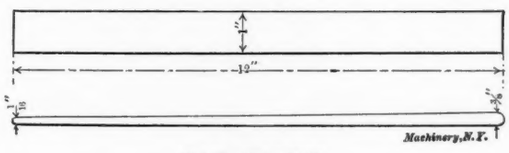


Fig. 2. Steel Drift.

Operations Before Placing Coils on the Core.—The core is mounted in a winding lathe, as shown in Fig. 4. If duck blankets are used they should be placed on the shaft before the core is placed in the winding lathe. If a block is used on the rear end of the armature core to shape the coils as they are wound or to protect the cast iron end-bell, the block should be placed on the shaft before mounting in the lathe so that it will not be necessary to remove the core after it is partly wound. The core should be placed in the lathe with the commutator end at the winder's left. The commutator end of an armature may be distinguished by the key-way cut in the shaft next to the core for the commutator key; also on railway armatures the shaft opposite the commutator end is beveled and threaded to fit the pinion as in Fig. 5.

A description of the winding of a No. 38 B railway motor will be given in detail:

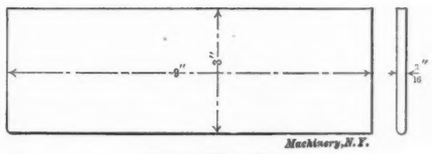


Fig. 3. Fiber Drift.

The core of this armature is built on the shaft and has three ventilating ducts parallel to the shaft. There are 45 slots. These slots are relatively narrow as compared with the width of the teeth. It will be seen from Fig. 6 that the end plate of the commutator end fits against a shoulder turned on the shaft. The rear end plate is held in position by a nut which is screwed on to the shaft and held in place by a setscrew.

Two duck blankets are used on this armature. They should be placed on the shaft with the wider side of the blanket out and with the seam toward the core. The core should be inspected to see whether any of the laminations or fingers project into the slots. The steel drift and rawhide mallet are used to clear the slot of any of these projections.

Cells.—In each slot are placed cells of paraffined express paper. They are made of a width such that when folded and placed in the slots the edges will project above the core, and thus protect the coils as they are placed in the slots. The cells are stiff enough so that when bent into the slots they are not easily shaken out, as the armature is revolved in winding. If any cells are longer than the slots they should be cut off so that both ends of the cells will be flush with the ends of the slots.

Coils.—In winding this armature, 45 complete coils are used. Each coil, *i. e.*, complete coil (See Fig. 7), is made by assembling in a cell three individual coils each consisting of two turns of No. 9, double cotton covered wire. Each slot contains one side of each of two different coils. One side of a coil is put in the bottom of one slot and the other side in the top of another slot. Three wires or leads are brought out from each side of the coil on the under side. This type of coil is known as a "three-lead coil."

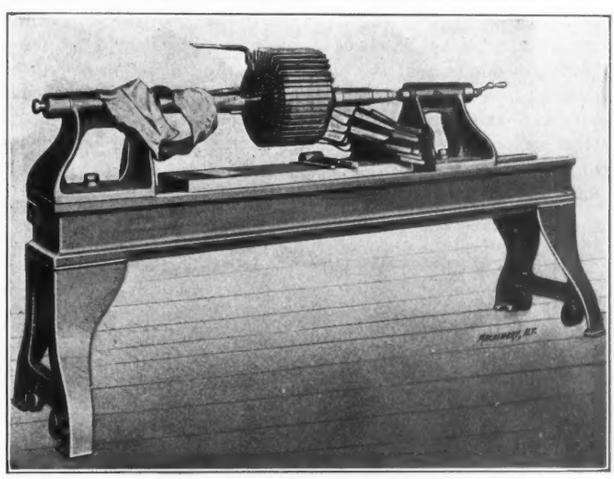


Fig 4. Winding Lathe.

Taping.—The middle lead of the three coming from the bottom side of the coil is taped with black tape, the outside lead is taped with white tape and then all three leads are taped together. The top leads are not taped but are bent up and outward, as shown in Fig. 8.

Putting Coils in the Slots.—Beginning with any slot the

* A. C. Jordan in the *Electric Journal*, December, 1905.

bottom of a coil is placed in it so that each end of the coil is at an equal distance from the core, the top of the coil resting on the core. The bottom of the coil is forced to the bottom of the slot by means of the fiber drift and mallet. Call this slot No. 1, and count toward the top of the coil until slot No. 11 is reached. Start the top of the coil in this slot. This is called a throw of 1 and 11, or simply 11. The tops of the first ten coils are not forced into the slots as they must be taken out when the last ten coils are put in place (See Fig. 8). The bottom of the next coil is placed in slot No. 45, and the top in

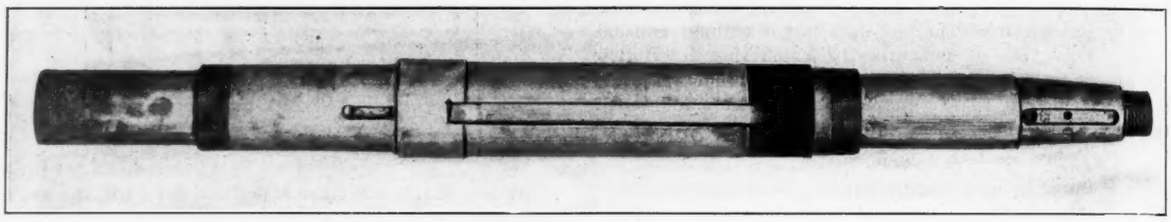


Fig. 5. Armature Shaft.

No. 10. After the first eleven coils are in place the tops should also be driven into the slots. Continue in this manner around the armature until slot No. 11 is reached. Beginning with slot No. 45, take out the tops of all the coils up to and including the one in No. 11 slot and bend them away from the

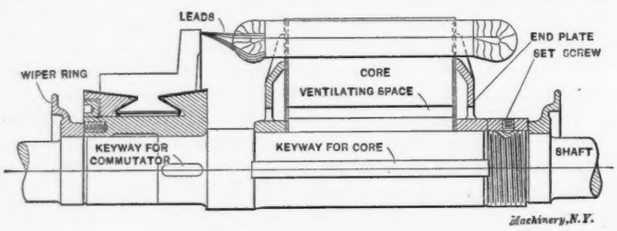


Fig. 6. Section through Armature.

armature so that the bottom sides of the last ten coils can be placed in the slots. After the last ten coils have been placed in position, the tops of the coils which were removed to make place for the last ten coils are put in place.

A piece of heavy wire is wrapped around the coils at each end just outside the core and tightened with the pliers as firmly as possible. This is to hold the coils in the slots while the winding is being tested, trued and connected. If the upper leads are not bare at the outer ends, the insulation should be scraped from them for about three inches. All the upper leads are then connected by a fine copper wire. Care must be taken that no leads touch the core or shaft as the leads are not required to be insulated sufficiently to withstand the voltage used in the insulation test. This test consists in applying

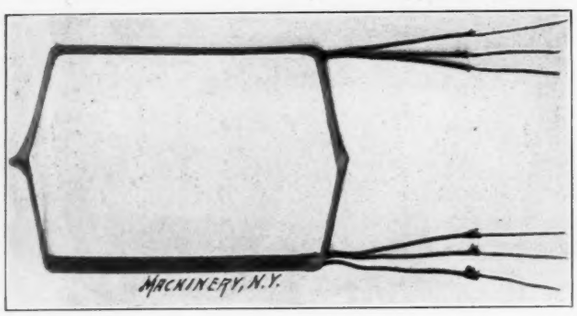


Fig. 7. Armature Coil.

3,600 volts between the winding and the core. If the test shows a ground in any coil, the coil is removed and a new one substituted.

After the armature has passed the insulation test, the tops of the slot cells are cut off even with the core. Then the tops and ends of the coils are trued. To do this the armature is revolved in the lathe and a piece of chalk is held so that in turning the armature it will mark the coils that project. These are then driven down, or the others are brought out even with the high ones. The fronts of the coils are then trued. In Fig. 9 parts of the winding being trued are marked with white chalk.

The blankets are next fitted over the front ends and sewed on with a curved needle and wax thread. The thread is passed in under the ends of the coils and brought up through them near the core and tied firmly over the blankets. They should be tied in at least six different places. The blankets are to separate and insulate the leads from the ends of the coils after the leads are connected to the commutator (See Fig. 10).

The winder then stands on the opposite side of the lathe and takes the bottom lead of any coil and counts seven slots in a clockwise direction facing the commutator. This lead is bent up and across the ends of the coils and held in place by the lead from tthe seventh slot. Proceeding in the same manner around the armature in a counter-clockwise direction facing the commutator, all of the lower leads are bent like the first one and secured by the upper leads. This finishes the operation of winding. The armature is now ready to have a commutator pressed on.

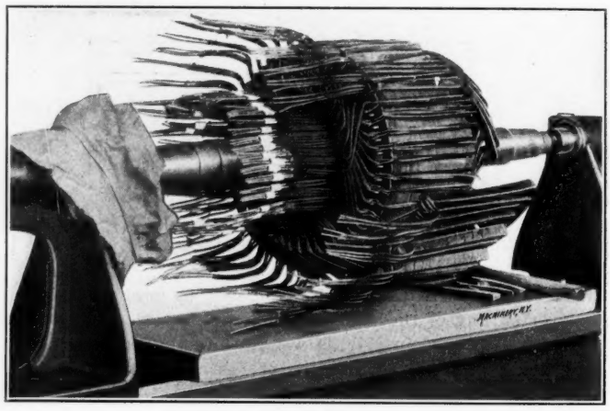


Fig. 8. Inserting the Coils.

Pressing on Commutators.—Small commutators are pressed on to the shaft by a hand press. All of the larger commutators are pressed on by means of a power press. In Fig. 11 is shown a hand press. The plate *B* is used in removing old commutators. It is placed back of the commutator as at *x y*

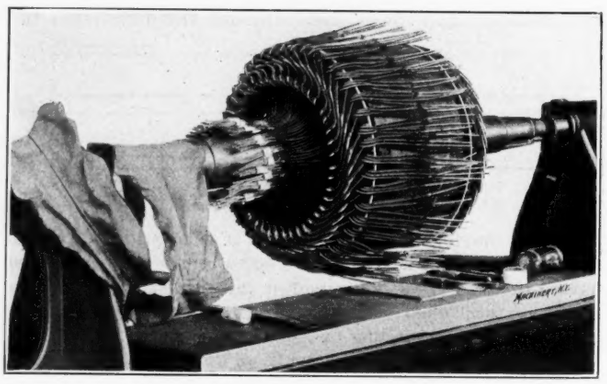


Fig. 9. Truing-up the Winding.

with the slot *C* over the shaft. Bolts *a b* are passed through the holes *a a* in the plate and secured by nuts. The commutator, can then be forced off the shaft. In pressing on a commutator, a sleeve is placed over the shaft at *O*, and rests

against the commutator. The rear end of the shaft is secured so it will withstand the pressure, and the commutator is forced on. The power presses are built on the principle of a hydraulic press. In pressing on a commutator a piece of babbitt metal or soft brass should be used against the end of the shaft. The shaft should be painted with white lead before having the commutator pressed on, in order to lubricate the shaft so that the commutator will press on easily. The wiper rings are pressed on after the commutator and then the armature is ready to be connected.

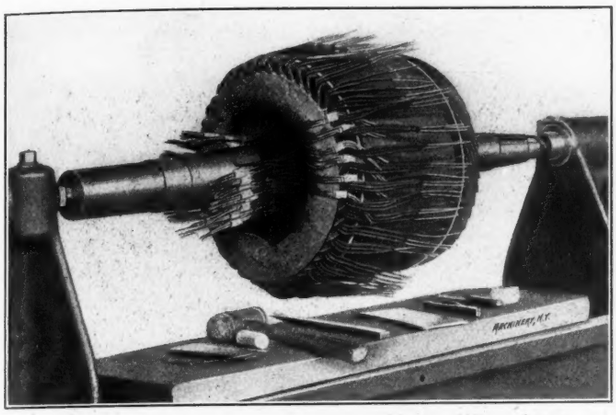


Fig. 10. Fitting the Canvas Blanket.

Connecting.—The first operation necessary in connecting is to "lay-off" the commutator. In "laying-off" the upper and lower leads of any coil are found by means of a lighting-out set. The slots which contain this coil are marked with chalk. In connecting a No. 38 B railway motor armature the following should be noted: There are 135 bars in the commutator. The throw of coil is 1 and 11 and, as the winding is progressive the commutation throw equals

$$\left(\frac{\text{number of bars} + 3}{2} = 69\right) \text{ is 1 and 69}$$

With this commutator throw the center of the throw will be a bar. The throw of a coil is 1 and 11, therefore, the center of

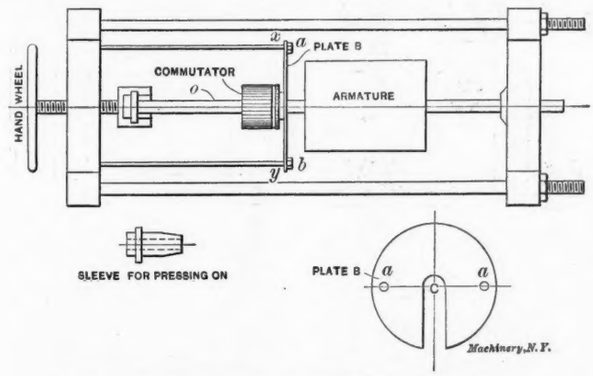


Fig. 11. Press for Forcing on and Removing Commutator.

a coil throw will be a slot. Hence every slot should line up with a bar. By holding a pencil on the commutator perpendicular to it and sighting along the side of a coil the bar opposite the center of the slot in which the side lies may be located as at *A* in Fig. 12. Mark this bar with a colored pencil. Find the bar opposite the other side of the coil, as at *B*, and mark with the pencil, calling the slot in line with *A*, No. 1. Count 20 bars from *A*, in a clockwise direction and mark this bar No. 1. Also count 20 bars from *B* in a counter clockwise direction and mark this bar No. 69. Count from this bar to and including bar No. 1 and there should be 69 bars. Also there should be 29 bars between *A* and *B*. *D B A C* is called the forward throw and *D C* is the back throw. It is seen that the back throw is 66 or three less than the forward, as it always will be in a four-pole, progressive wave-wound armature. If an armature is wound retrogressively the forward and back throws differ by one. If, in laying-off, the center of the slot does not come in line with a bar, find one that will line up with a bar and proceed as above.

The 38B armature has three leads on each side of a coil and as there are 135 bars, there is no idle coil in this winding. Place the middle lead of the three coming from the bottom of slot No. 1 in bar No. 1, the outside lead in bar No. 135 and the inside lead in bar No. 2. Next take the lower leads from slot No. 2 and place them in bars No. 3, 4, and 5. The insulation should be removed from the leads where they are to be soldered to the commutator necks. They are driven to the bottom of the slot by means of a tool similar to the wedging tool only much thinner. The lower leads are all placed in the commutator and then they are "lighted-out."

Lighting-Out.—The purpose of lighting-out is to see that there are no grounds or short circuits between the bars or coils, and to see if the leads are connected to the proper bars.

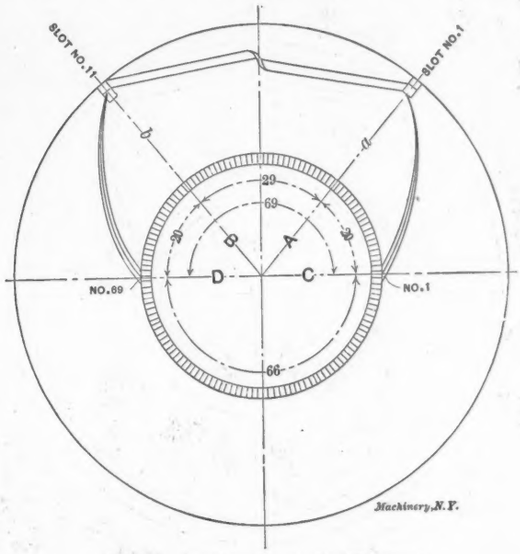


Fig. 12. Armature Connection Diagram.

The lighting-out set consists of two terminals connected in series with a 110-volt incandescent lamp to the 110-volt service lines.

One terminal of the lighting-out set is placed on bar No. 1 and the other on the middle lead coming from the top of same coil. The lamp should light. Next move the terminal on commutator bar No. 1 to bar No. 2 and if the lamp lights it shows a short-circuit between bars or between coils. If the lamp does not light the upper terminal is moved to the next lead counter-clockwise, when the lamp should light; if not, find the bar on which it will light and bring the wire connected to that bar to the proper bar. Continue in this manner around the commutator. After the winding is lighted-out, the ends of the leads projecting out over the commutator beyond the neck are cut off and saved as they are to be used again.

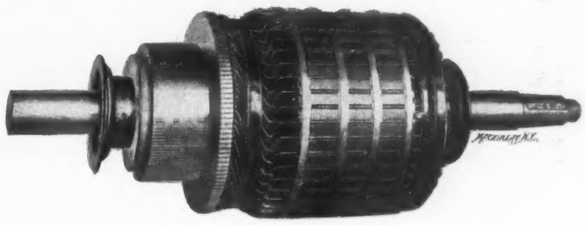


Fig. 13. The Completed Armature.

Two layers of friction cloth are then wound over the lower leads and then the upper leads may be connected. The center lead from slot 11 is connected to bar No. 69, the outside lead is connected to bar 70, the inside lead from slot No. 12 is connected to bar No. 71, and so on around the armature. After the leads are all placed in the slots in the commutator necks, they are driven to the bottom of the slots. The lower leads which were cut off are known as "dummies." These are driven into the tops of the slots until the slots are full. After putting in the dummies, all projecting ends are cut off and the

armature is tested for grounds and short circuits. The leads are then soldered in the slots and the armature is then ready for banding.

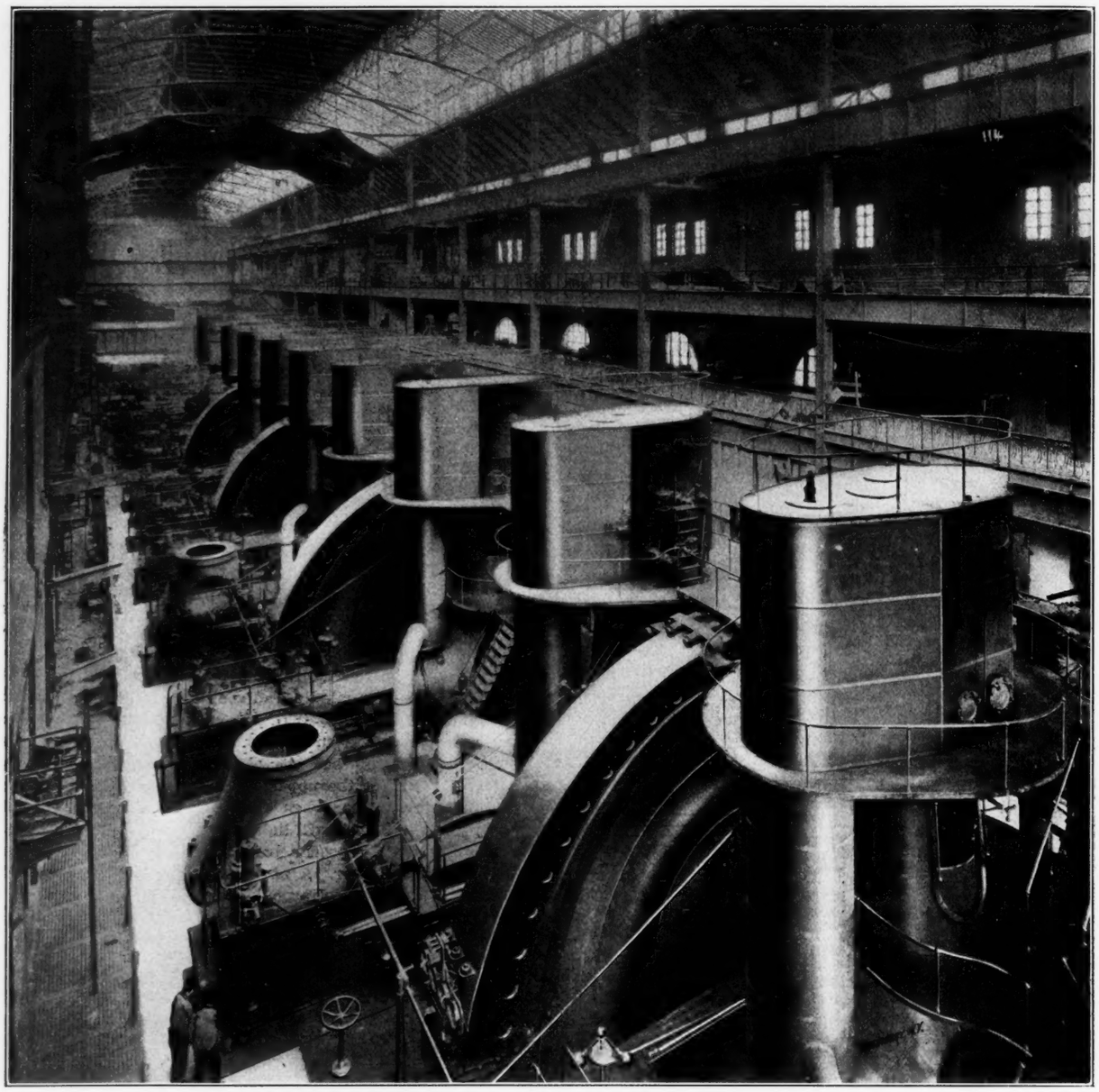
Banding.—Tinned steel wire is used in banding. The bands on the core are insulated with mica and fullerboard while on the coils they are insulated with Japanese paper and tape. The insulation is made wide enough so that it projects one-eighth of an inch on each side of the bands. The bands on the core and leads are five-eighths of an inch wide, while the ones on the ends of the coils are made as wide as possible. In putting on the bands the armature is rotated in a lathe and the steel wire is wound on under tension. Clips are placed under the band wires and after sufficient turns have been wound on, the clips are bent over the wires and soldered to them, so that the band wires are held firmly together. After the bands are all on, they are heated with a soldering iron and solder run around each band. Thus the wire and clips are all held firmly in place.

Seven strips or bands are placed on the armature, four on the core, one on each end of the coils and one to hold the leads in place. These are shown in Fig. 13. The two bands on the rear end of the coils are connected to the last band on the core by means of three anchor clips spaced equally around the armature. This is done so there will be no danger of the outer bands slipping. After the armature is banded it is tested for short-circuits or grounds, given a coat of insulating paint and is then ready for assembling with the other motor parts.

* * *

INTERBOROUGH RAPID TRANSIT CO. TEST OF SUBWAY ENGINES.

An interesting official fifteen-hour test of one of the nine twin vertical-horizontal Reynolds Corliss engines, cylinders 42 inches and 86 inches by 60 inches, which have been in operation at the 59th Street station of the Interborough Rapid Transit Co., New York City, since 1902, was concluded December 15.



The Engine Room of the Fifty-ninth Street Station of the Interborough Rapid Transit Co.

The tests were conducted by the Interborough Rapid Transit Co. and representatives of the Allis-Chalmers Co. as a final determination of the fulfillment of the builder's guarantee and formally provided for in the original contracts.

How well the tests of engine No. 8, which was selected as representing all the engines installed, fulfilled the claims made for it, may be readily ascertained from the following data, giving a synopsis of the completed tests.

As per agreement, on account of the impossibility of keeping a constant load, the power was determined by the readings of tested integrating wattmeters. These readings were reduced to I. H. P. by running the generator as a synchronous motor;

adding the electrical input to the switchboard readings when developing power, to obtain the power exerted by the engine.

The result of the test so made, under conditions approximating the contract requirements of 7,500 horse power, 75 revolutions per minute, 175 pounds steam pressure, and 26-inch vacuum, was a consumption of 11.96 pounds of dry saturated steam per I. H. P. hour, or well within the guarantee of 12.25 pounds. The steam consumption per kilowatt hour at the switchboard was 17.34 pounds.

Duration	15 hours
Load	5,079.2 K.W.
Friction and generator losses	417.3 K.W. = 559.41 H.P.
Total load	5,496.5 K.W.
I.H.P.	7,365.3 H.P.
R.P.M.	75.02
Steam pressure	175.18 lbs.
R.H. receiver	19.1 lbs.
L.H. receiver	19.27 lbs.
Vacuum	26.02 inches (actual)
Temperature injection water	42.36 degs.
Temperature R.H. discharge	74.05 degs.
Temperature L.H. discharge	77.38 degs.
Barometer	30.50 inches
Water per hour	89,906 lbs.
Drips per hour	512 lbs.
Leakage per hour (boiler)	1.470 lbs.
Boiler level correction	60 lbs.
Net water per hour	87,864 lbs.
Quality of steam	100.28 per cent
Dry steam per hour	88,110 lbs.
Dry steam per K.W.H.	17.34 lbs.
Dry steam per I.H.P.H.	11.96 lbs.

The final results allow for boiler leakage, which was determined by a separate test of twenty-four hours' duration. The steam was very slightly superheated during the test, as being easier to make allowance for than wet steam, and a correction was made to reduce the superheated steam to equivalent dry saturated steam.

The vacuum was carried at 26.02 inches, or as near the contract requirement as possible, but the barometer stood at 30.50 inches. The vacuum was, therefore, equivalent to only 25.52 inches referred to 30-inch barometer; no correction was made, however, as none was provided for in the contract. Other tests at varying vacua show that if the vacuum had been carried enough higher to correspond to 26 inches vacuum when referred to 30 inches barometer, the steam consumption would have been about 0.09 pounds better, or 11.87 pounds per I.H.P. hour, instead of the official figure of 11.96 pounds.

The tests were made under the supervision of Frank N. Waterman, who acted as referee. The following represented their several companies: Interborough Rapid Transit Co.—H. G. Scott, superintendent motive power; J. Van Vleck, mechanical engineer; H. W. Butler, principal assistant engineer; Thos. Allsop, mechanical engineer, 59th Street power station; C. W. Picker, electrical superintendent; G. F. Chellis, instrument man; W. L. Seabrooke and W. S. Finlay, assistant engineers.

Allis-Chalmers Co.—A. M. Mattice, chief engineer; Samuel Moore, district superintendent of erection; T. T. Hubbard, engineer test; J. W. Lord, sales representative; C. A. Hoppen and C. J. Larsen, construction department; A. F. Rolf and F. Buch, electrical representatives.

* * *

A new type of electric converter was exhibited at the Brussels exhibition, being what is known as the permutator. This machine, which is for the conversion of alternating current into direct current, has no revolving armature; the lines of force in the stationary winding are cut by a revolving field which is obtained by means of polyphase currents. The brushes are revolved around the commutator instead of revolving the commutator as in the synchronous converter. The advantage of the machine is that it can be brought to full speed in a few seconds, there being little inertia in the revolving brushes as compared with an armature. Again there is no air gap so that the magnetic leakage should be small. A disadvantage, though not serious, is that the brushes revolve and this complicates the matter of brush adjustment with the developed centrifugal force, which must be counteracted at the normal speed so as to give the required brush pressure.

REPRESENTATIVE AMERICAN MECHANICS.

JOHN RICHARDS.*

For the last twenty-five years, amongst technical men on the Pacific Coast and especially amongst those devoted to mechanical engineering, no name has been more widely known than that of John Richards. Young inventors have sought his help to get into trouble and old inventors have sought his help to get out of trouble. There are few problems connected with mechanical progress in whose solution Mr. Richards has not, at some time or other, taken part, while his genial disposition and rigidly upright character have always enabled him to count among his devoted friends the best men in the engineering profession, not only on the Pacific Coast, but wherever engineering is considered an honored profession.

Mr. Richards is of Scotch extraction, the son of a physician, and was born in Pennsylvania in 1834, whence the family removed to southern Ohio in 1844. Here young Richards attended public and private schools until 1848, when, at the age of fourteen, he was sent to learn millwrighting, which at that time included the erection and care of steam engines, and for some time acted as a stationary engineer. He served also for about two years as a steam-boat engineer on the western rivers. About 1854 Mr. Richards, thinking that the life of a steam-boat engineer was too contracted, left the river and began to qualify himself as a works foreman, serving terms at cabinet work, joiner work, wood construction in millwrighting, and machine fitting. In 1859, on account of some notable improvements made by him in apparatus for turning out wooden screws, grinding edge tools, etc., he was appointed a division foreman in the Ohio Tool Company's Works at Columbus, Ohio. Here he began improvements in the plant and in various processes involved in that large company's business, became general foreman and finally, in 1864, superintendent, an office Mr. Richards still holds, nominally at least, as there has never been a successor. While working himself into notice as a skilled mechanic, during the eight years he was at Columbus, he did not lose sight of other possibilities in the future, so he studied under private tutors the science of engineering and mathematics, qualifying himself for designing as well as executing.

In 1867 Mr. Richards became a charter member, director and constructing engineer of the J. A. Fay Co., of Cincinnati, Ohio, and began a remodeling of wood working and kindred machinery of various kinds. In 1869, at the suggestion of Mr. W. B. Bement and Mr. William Sellers, senior members of the two principal machine tool works in this country, Mr. Richards sold out his interests in Cincinnati, and, after a trip to Europe to examine into the state of the art in wood working

* Contributed by Geo. W. Dickie.

and other machinery there, settled in Philadelphia and founded the Atlantic Works (Richards, Thorne & Co., afterwards Richards, London & Kelley) for the construction of a superior class of wood working and other machines, especially for use in railway car building establishments. In 1873 Mr. Richards went to London and prepared there a treatise on wood cutting machines, a quarto volume containing a history and description of the methods and practice in the United States, France, and England. This work was sold at twenty-five shillings ($6.00) and has been out of print since 1880, but still remains one of the principal reference books in the wood cutter's art. This was followed by another book published in London in 1874, "The Operator's Handbook for the Instruction of Foremen and Workmen in Wood Converting Processes." This went through several editions but has long been out of print. In 1875 Mr. Richards began contributing articles to "Engineering," London, on various branches of constructive engineering work, some of which were afterwards published in book form under the title of "Workshop Manipulation." In 1877 he started the American Standard Gauge Works at Philadelphia, which is still being successfully conducted by other owners.

The partnership of the Atlantic Works expiring, Mr. Richards retired from that business and founded the firm of Richards and Atkinson at Manchester, England, makers and importers of machine tools. This business after going through some changes was absorbed in George Richards & Co., Ltd., Manchester, England, George Richards of that company being the only son of the subject of this sketch and a noted authority on machine tools in England. A branch of the English business was established at Gothenburg, Sweden, and was placed under the management of George Richards, then a student.

In 1880 Mr. Richards, considerably broken in health through over work, came to California where he met the writer and formed with him a close and lasting friendship. Here he founded the San Francisco Tool Co., at first makers of machine tools and later of hydraulic and other machinery. After conducting this business successfully for five years Mr. Richards went back to Manchester, England, to assist in organizing and expanding the company's business there, in which he was still a director, and on his return a year later, spent some months in Pittsburg with the Westinghouse Company, assisting in the development of single-acting steam engines and centrifugal pumps. On again reaching San Francisco, Mr. Richards found that the San Francisco Tool Company had taken contracts for railway building and other work not contemplated by its founder, so he refused to retain his connection with it, and, after assisting the writer with some special work in connection with the Union Iron Works, he turned over to W. T. Garratt & Co., of San Francisco, his patents, patterns, drawings, etc., and gave up direct connection with shop work, after an active and varied business experience of about thirty-five years.

Such an active mechanical engineer as Mr. Richards, could not be content, however, without having some share in the engineering activities of the Pacific Coast, so in 1888 he founded the magazine "Industry," a high class technical journal devoted to the industries of the Pacific Slope. The work accomplished by this magazine had a stimulating effect on all mechanical engineering work carried on by Pacific Coast engineers. The writer notices to-day the eight bound volumes of "Industry" occupying a prominent place in not a few of the reference libraries used in the offices of the prominent engineers here. After a successful run of eight years, "Industry" had to be abandoned for want of time and strength to prepare the subject matter for its pages, which was mostly original work for each issue.

In 1889 Mr. Richards published at Philadelphia a manual of machine construction, which contains what the writer believes to be the first attempt at tables of proportions for common machine parts. He was elected president of the Technical Society of the Pacific Coast in 1889 which office he held for three years and still, as an honorary member, contributes more or less each year to the transactions of that important organization. Mr. Richards although having earned an honorable freedom from the exacting duties of an engineering profession, has yet been unable to keep his hands and brain clear of the new problems that are ever confronting the engineer. So we find him in 1903 again taking up hydraulic work, visiting Switzerland and other parts of Europe to investigate the progress made in rotative pumping machinery, and going into harness as the president of the Turbine Pump Company of New York, which position he resigned several months ago.

Mr. Richards still attends to his consulting business in San Francisco, including the presentation and prosecution of patent cases, especially in foreign countries, and also acts as president of the North Side Water Company. He resides on a fine country place named "Ancho Vista," at San Anselmo, from whence he comes daily, about sixteen miles, to his office in San Francisco.

The class of mechanical engineering on which Mr. Richards has left his impress has been mainly that of implements and processes for manufactures in woods, metal, standard gages for accurate dimensions, steam turbines and centrifugal pumping machinery.

Mr. Richards does not like the American protective tariff system and is ever ready to protest against the artificial values it creates. He maintains that the American mechanic could hold the markets of the world if delivered from the restraints that the tariff imposes. His knowledge of foreign machine shop practice and that of this country has broadened his engineering sympathies, making him a fine specimen of a rare type, a real companionable mechanical engineer combining both the ancient and the modern. Mr. Richards has passed the three score years and ten and is yet as interested in a new problem as the most eager aspirant for engineering honors. His friends unite in wishing him many years of future usefulness.

* * *

HOW LOOSE SCALE CAUSED A BOILER BAG.

A boiler insurance company had a hurry call to examine a boiler that was reported seriously injured. One of their boiler experts was dispatched to the plant, and found that a sheet over the grate had developed a "bag" seven feet long by three feet wide, with a depth of fourteen inches, and a rupture at the deepest part. The superintendent of the plant was alarmed. He had come to the conclusion that the bag was due to original defects in the metal. As there was another boiler of the same make at the plant, he was debating whether it would not be best to throw it out, having decided to abandon the injured one, because no cause could be given for the defect save poor material. The expert proceeded with his inquiry, and found the damaged boiler had been washed out on Sunday. It was then filled up, and was being fired when the bagging took place. At that time the steam pressure was forty pounds, while when in service ninety pounds was carried. The damaged plate clearly showed the usual marks of being overheated or burned all around the bag; and, where it was not burned, the metal had stretched, indicating beyond doubt, that originally, or prior to bagging, the sheet was of excellent quality. What, then, had caused the accident? The boiler had been reported thoroughly cleaned the day of the accident, and there were no traces of oil or grease. The superintendent was insistent that his theory was correct, and claimed that the boiler when it was cleaned was free from sediment or loose scale. The expert bade him wait until the examination was over. He then entered the lower manhead, and found at the rear end of the boiler about two and one-half bushels of loose scale which he carefully brought to the front. This huge mass showed clearly that the attendant had collected the scale on the sheet over the grates, and was ready to remove it from the boiler when he was called away, and on his return had forgotten the scale and placed the man-head in position, filled up the boiler, and fired up. The mass of scale of course allowed the plate beneath it to become overheated, resulting in the huge bag or bulge in the sheet. When the bulging took place the pack of scale opened up, allowing the water to come in contact with the red hot steel. This resulted in an instantaneous generation of steam that drove the scale to the rear end of the boiler.

* * *

Right angle fillets are 93 degrees on the right angle side.

THE NEW SHOP OF THE BALL ENGINE CO.

As an example of modern shop construction, we show this month a number of half-tone views and detail drawings of the new shop of the Ball Engine Co., Erie, Pa., located in the outskirts of the city. The building is of steel frame construction, with brick walls, and it has an unusual amount of window space, even for a modern structure.

shop and storage building, shown in plan in Fig. 4, which joins the main structure at *A*, Fig. 3, and will eventually form the connecting building between the machine shop and the foundry. At present the company are using their old foundry adjoining their old works in the heart of the city, but a new foundry is contemplated in the near future.

Fig. 2 is an interior view of the erecting shop and shows

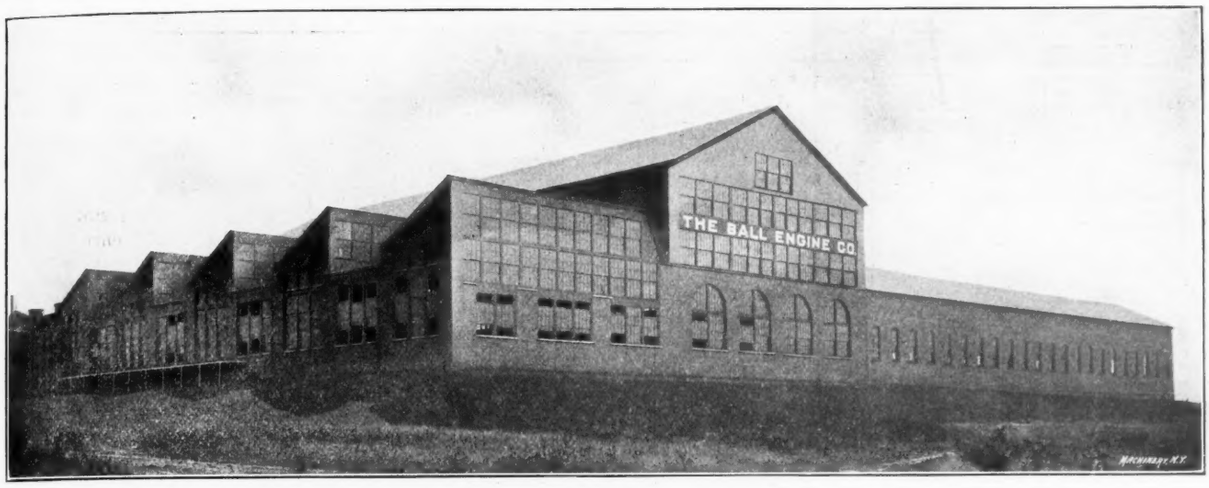


Fig. 1. General View of Ball Engine Co.'s Plant.

The main, or central part of the building, is the erecting shop, 70 feet wide by 200 feet long, with a wing on either side lighted by saw-tooth roof. The floor plan of the plant, showing the layout of the tools, is given in Fig. 3. The larger of

the excellent lighting secured by means of the side and end windows. The floor is served by a 25-ton Pawling and Harnishfeger crane, with head room of 55 feet under the crane. There are jib cranes suspended where needed from the columns

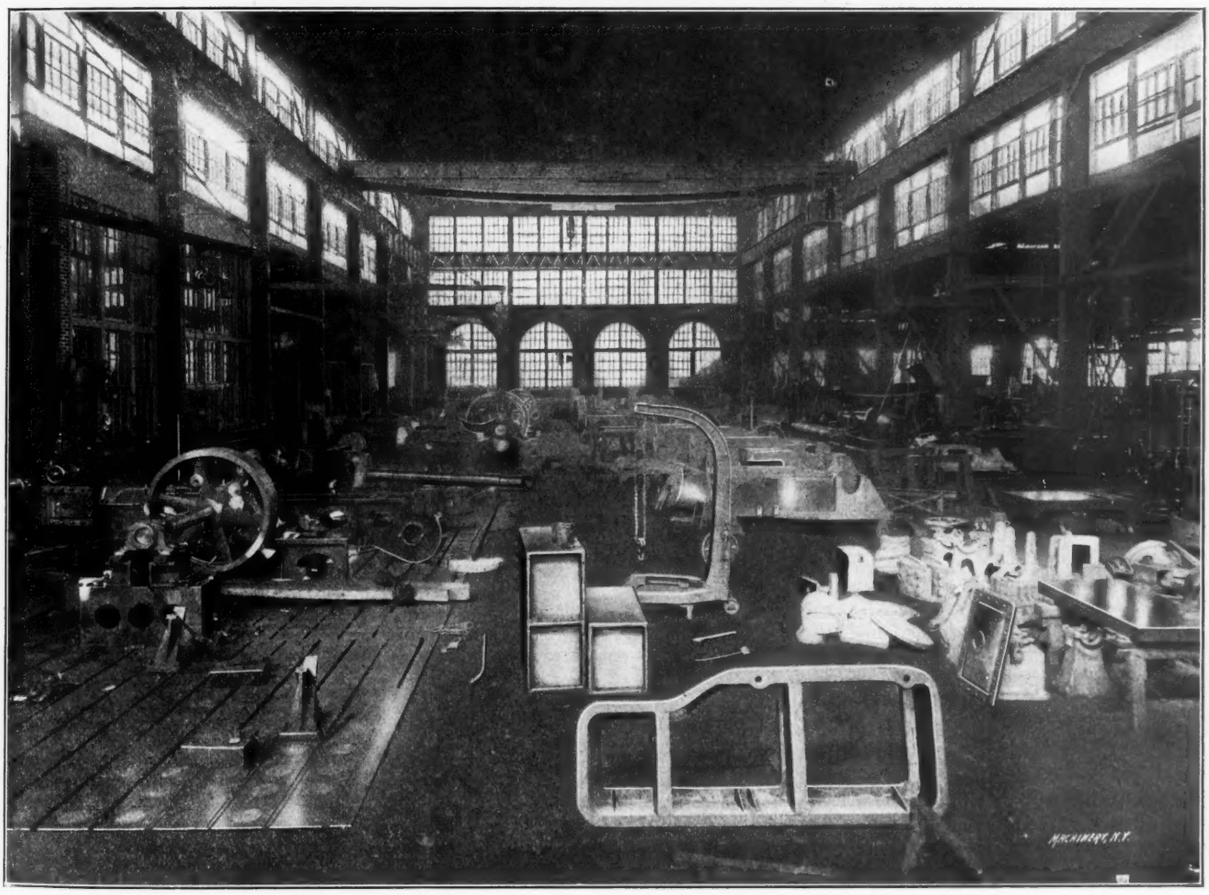


Fig. 2. Interior of Erecting Shop—Machine Department at the Right, Storeroom, Etc., at the Left.

the two wings is devoted to the manufacture of engine parts, and contains all but the largest of the machine tools. The smaller of the wings is occupied by the power plant, smith shop, store room, wash room, etc. There is also a carpenter

on either side serving radial drills, an open-side planer, and other heavy tools located in this department. In Fig. 2 a part of the machine tool or manufacturing department is visible, under the wing at the right. This department is served by

3-ton overhead traveling cranes, the tracks of which extend into the space of the erecting shop far enough to enable loads to be transferred from the smaller cranes to the 25-ton crane in the erecting shop.

The most novel feature of the plant is the design of the saw-tooth roof used for the two lower sections or wings. As machine shop floor, excepting the heavy tool foundations, is of concrete 12 inches thick in which are imbedded sleepers covered with tar, and maple flooring is laid on the sleepers.

An interesting feature of the erecting shop is the testing floor shown in Fig. 6, which is made up of cast-iron plates containing T-slots, on which engines of any size may be erected

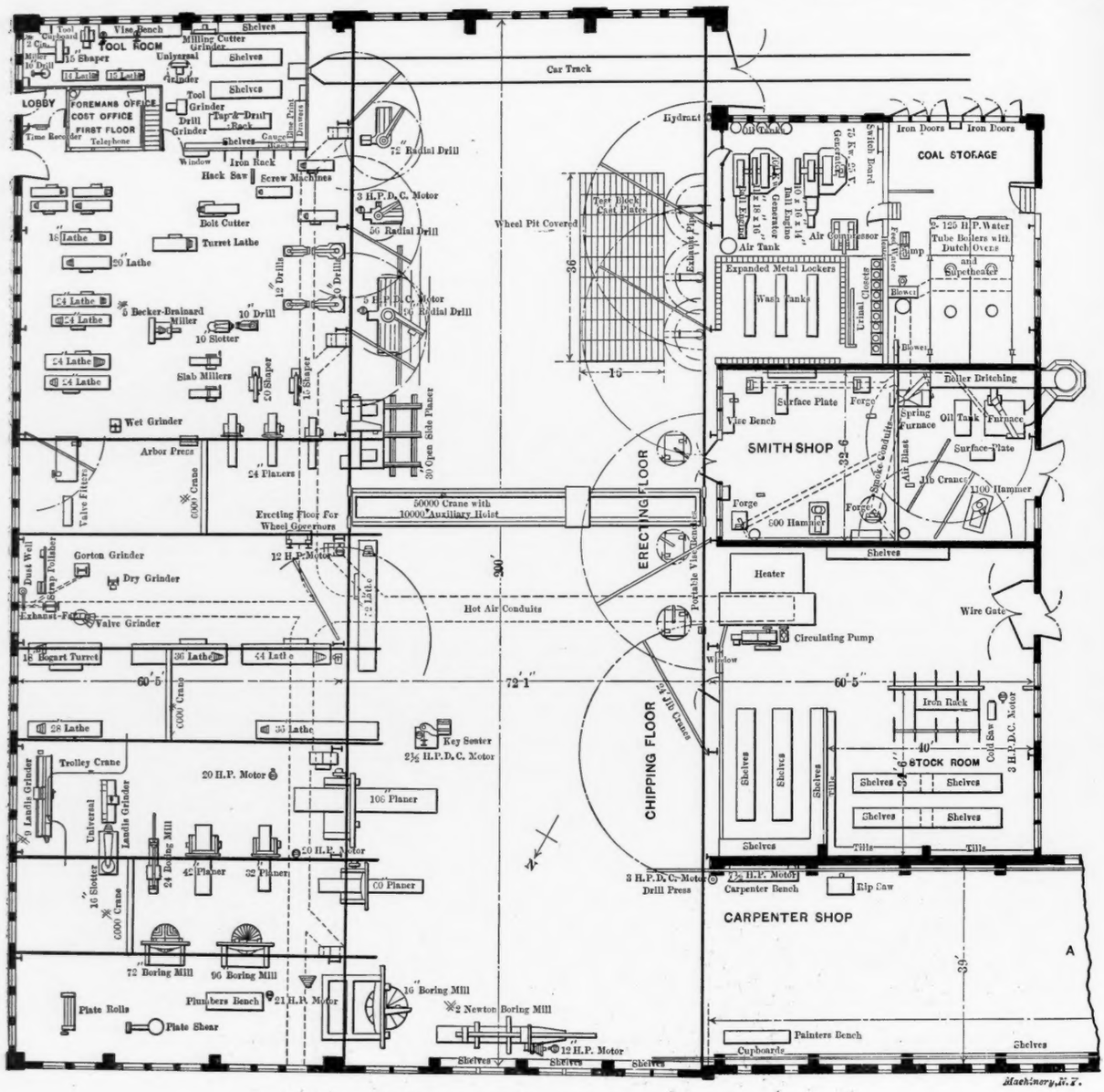


Fig. 3. Plan of Works, showing Lay-out of Tools.

shown in the interior view, Fig. 9, and also in the side elevation, Fig. 8, the saw-tooth parts of the roof alternate with flat sections several feet in width. Also, referring to the transverse section, Fig. 11, it will be noted that the saw teeth do not extend clear up to the erecting shop, but are beveled off, as indicated. The main object of this is to allow the wind to circle around the saw teeth of the roof, thus clearing the spaces between from snow. It incidentally provides a passageway on the roof beside the erecting shop wall and allows light to freely enter all the side windows of the erecting shop, where otherwise the saw teeth would obstruct part of the windows. The flat portions of the roof between the saw teeth prevent the snow banking up in the gutters, shutting out light and causing leaks, troubles that occur with the regular type of roof.

In the small tool department, a view of which is shown in Fig. 9, the countershafts are suspended beneath the saw-tooth sections, and beneath the flat places of the roof are located three-ton traveling cranes for serving the different tools. The

for testing. The illustration shows parallels on the testing plate on which smaller engines are mounted. The pipes leading from the steam main for connecting up the engines under

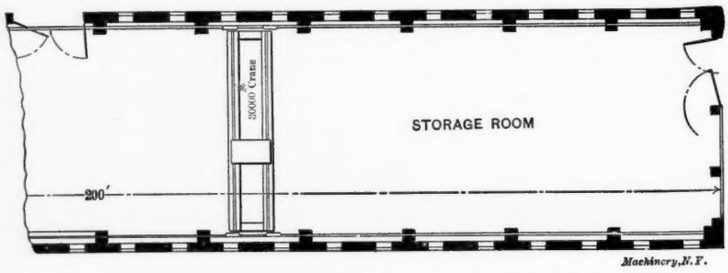


Fig. 4. Recent Addition for Storage. Joins above Plan at A.

test are fitted with universal joints. This allows the connections to be made easily and quickly without hunting up pipe fittings.

All parts of the plant are piped for compressed air, and an

air compressor is located in the engine room. In as much as steam is required intermittently for testing purposes, often in as large or larger quantities than for the power plant itself,

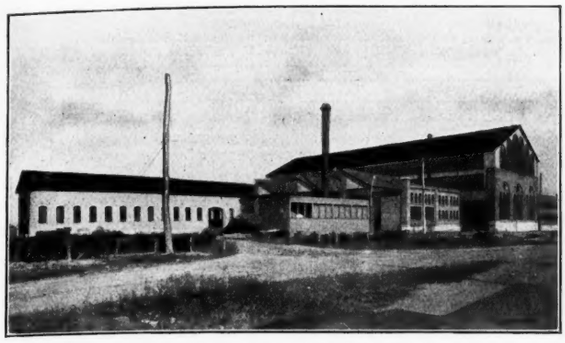


Fig. 5. View showing Storage Wing, Power House, Etc.

the boilers are equipped with mechanical draft and steam in any quantity, up to the maximum capacity of the boilers, can be generated, according to the requirements. In addition to forcing air under the boilers, the same blower is so connected as to exhaust the smoke and gas from the smith shop.

The grouping of the tools, as shown in Fig. 3 has been very carefully arranged to allow work of like character to be done in the same departments and to provide for the regular progress of the work through the shop, all parts moving toward the erecting floor. The supplies and manufactured stock are conveniently located immediately adjoining the erecting floor. The building can be enlarged, as future growth demands, by increasing its length or width or both. The offices are still situated at the old works in the heart of the city, but eventually will be in quarters at the new plant.

* * *

THE SHOP AND THE HOME.

HOW GEORGE MADE THE CAM FOR THE B. & S. MACHINE, AS TOLD BY HIS FOREMAN AND HIS WIFE, EMMA.

The Foreman—"Yes, George is a good man; he is a neat workman, steady, and is well liked by the other men. He has a good head on him, too. When they got in the first B. & S. screw machine they wanted it started up on a different job than what it was originally fitted up for, and there had to be a new cam made for driving the gripping and cutting off movements. I asked George if he could do it, and he said: 'Yes, I guess so, if you give me a little time.' 'Take all the time you want,' I said, and he went ahead and made the cam and it worked all right the first time he tried it, and now he lays out all of them, and the milling machine man cuts them out. He has his odd spells, though; he came in one morning with fire in his eyes and asked for a raise and said he wanted

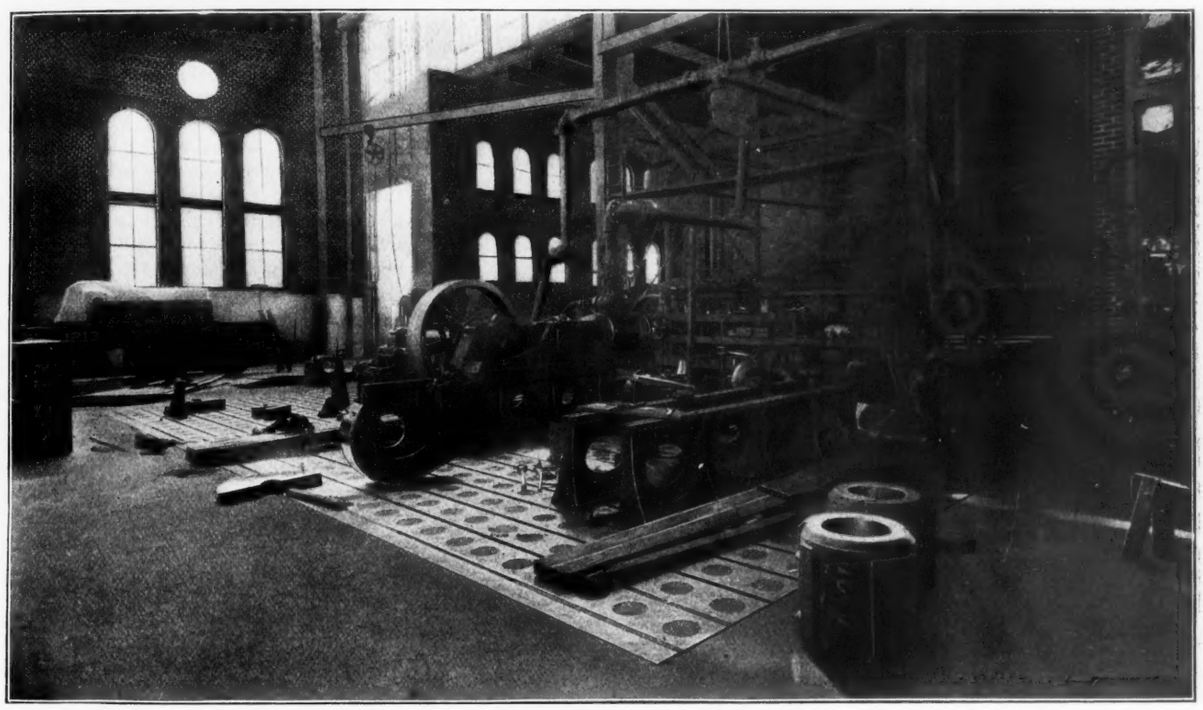


Fig. 6. Testing Plate in Erecting Shop.

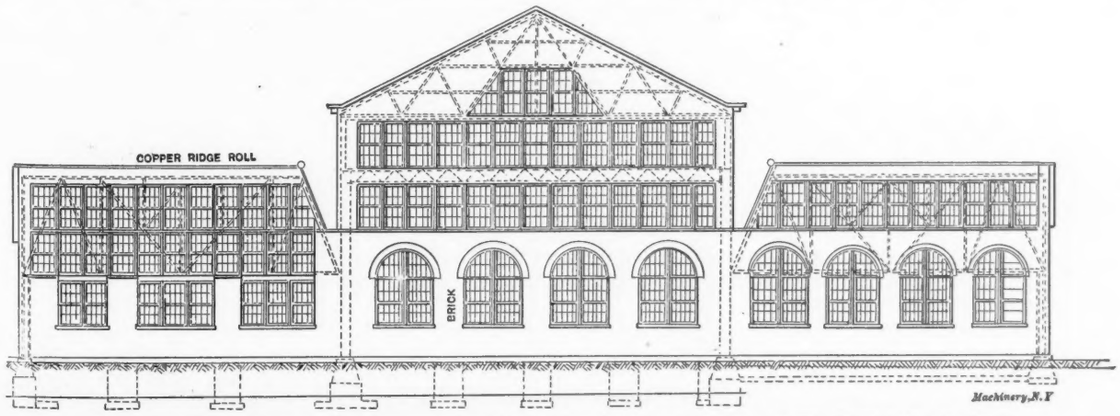


Fig. 7. End View of Shop showing Passage-ways between Saw-tooth Roof Sections and Side Walls of Erecting Shop.

it right then and there, or his discharge. We were paying him $3.25 per day, and I had meant to make it $3.50 long before, and I told him so, and so it was all right. But I never could understand why he was so hot about it. If it had been some men I should say he had been drinking, but he don't touch a drop, so I know that was not it. * * * Well—— Good day."

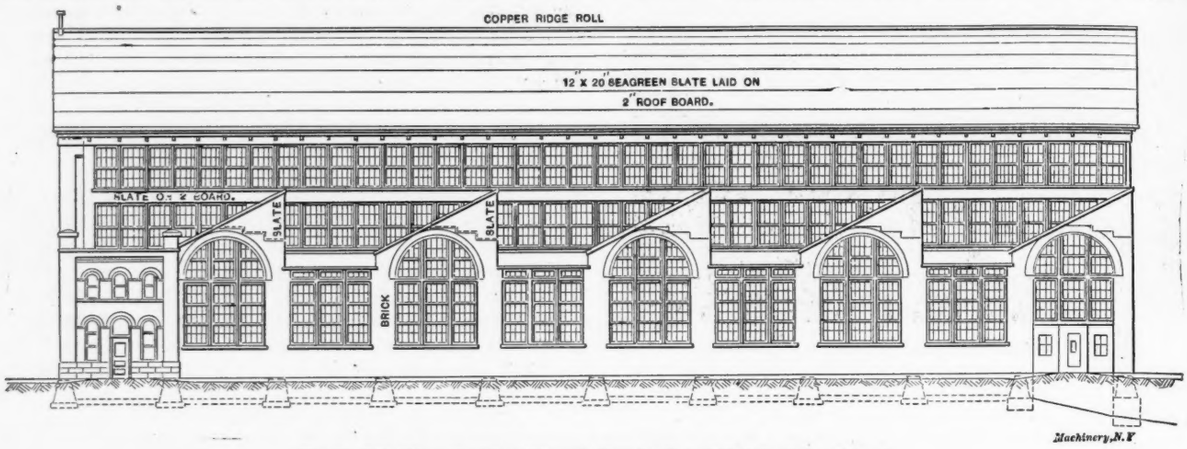


Fig. 8. Side View showing Alternate Saw-tooth and Flat Sections of Roof.

Fig. 9. Interior of Machine Department, in one of the Saw-tooth Roof Wings.

George—"Yes, I am still at the B. E. Co. and I guess I will stay there as long as I live. It's a good shop and a good crowd to work with, and you get lots of nice jobs to do and a chance to use your head; more than you would in some shops. When the first B. & S. screw machine came in we had to set it up for a new screw from what the tools were designed for, and the 'Old Man' had me lay out a new cam. It was a very interesting kind of a job; you see it was like this: It had to have 30 degrees to cut off in, and then a 30-degree dwell, and then 15 degrees more to back out in, and all I had to do was to give it one-third more dwell, and then time it so it would still do the work and get away soon enough for the chuck to open and let the rod feed in the next piece, say 8 or 10 degrees. It looks real easy and simple as I explain it to you, but it took me two days to get it through my head, but it is very easy now, you see, don't you? Yes, I got a raise a time ago, and the 'Old Man' said he meant to have done it long ago, if he had only thought of it. Emma says that I talk wheels too much home anyway, but I guess that's a thing that all the women say. Well—So long."

Emma—"Yes, George is still working at the B. E. Co. It's a real steady shop, and it is so close to the house that the baby can watch him clear down to the gate from the window, and I guess he will stay there right along. * * * No, I really don't know what the work is, but I think some of it is real large. I know he had a cam to make several weeks ago, and it was 20 degrees one side and 15 degrees the other, so I know it must have been awful big. I know a degree was 69½ miles when I went to school, but I don't understand how they ever could have got it in the shop if it was as big as that; anyway, what do you think? George had hold of while he was making it. I woke up one night with an awful pain in my neck, and what do you think ? George had hold of my shoulder and was twisting it as hard as he could, and when I asked him what he meant he said that he was dreaming about that cam, and that he was trying to set it ahead a little to make it work better. I don't know what he meant, but I know my shoulder is lame yet. There was one night when he got up to warm the baby's milk. You know we use that little lamp with the tin chimney on it nights, and he had warmed the milk, and instead of turning it into

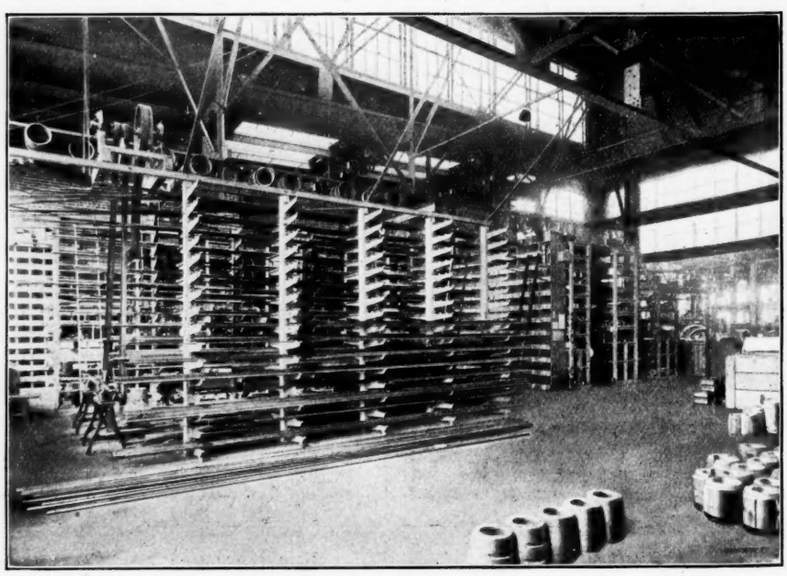


Fig. 10. Stock Rack.

the bottle he turned it down the chimney. Of course the light went out; it left us all in the dark, and when I asked what he meant he said he was thinking about that cam. But he got it braced him up good, and then I sat in the window and watched him clear down to the shop and told him to go straight to the boss as soon as he got into the shop and go for it. They gave

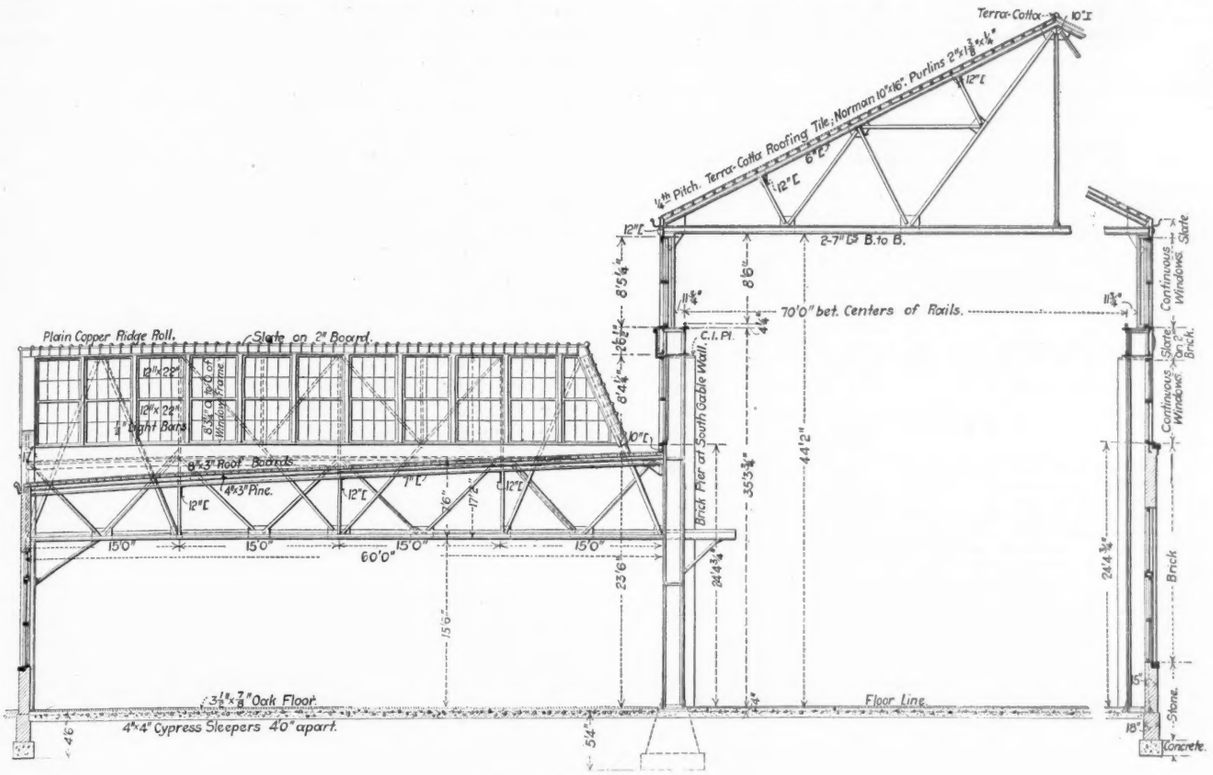


Fig. 11. Half-section of Plant.

done finally, and he has made two or three since then, but I guess they must have been small ones; they didn't seem to bother him anyway. * * * Yes, he got a raise but a little time ago. I talked and talked, but he was afraid he would get it to him, and said they would have given it to him long before if he had only spoken of it. * * * Yes, the baby is real well and we are getting along nicely; only I hope George won't have to make any more cams.

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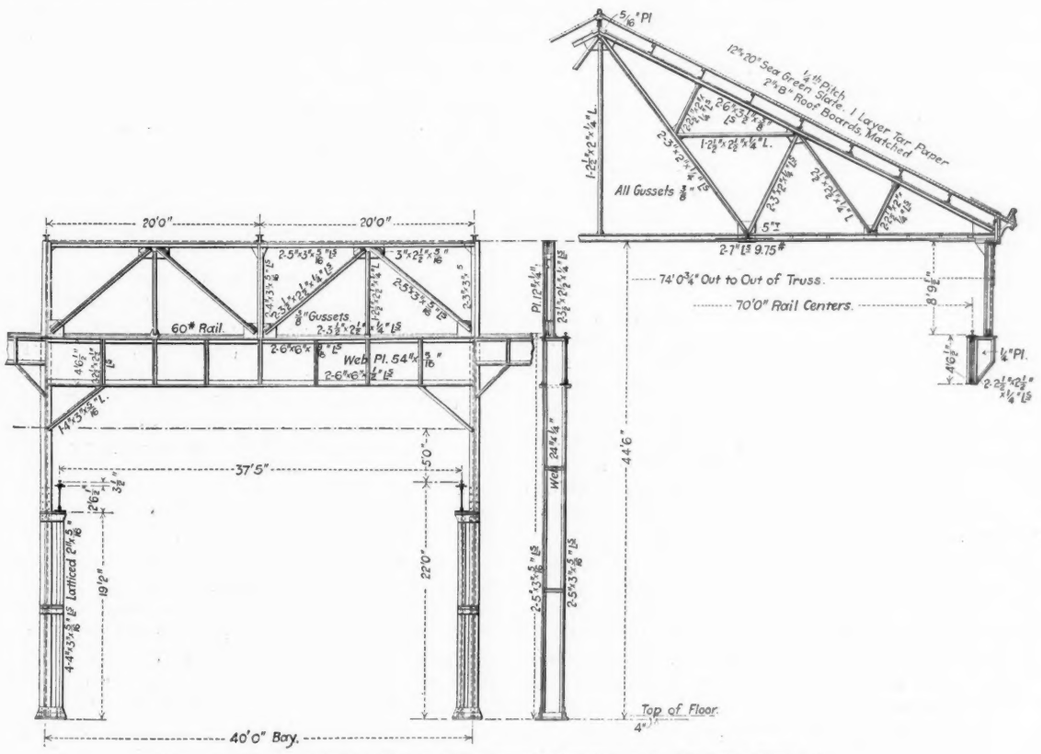

Fig. 12. Details of Roof of New Storage Building and of Erecting Shop.

fired if he asked, and finally I told him I would take in washing if necessary to keep the house going until he got another job. Then one morning I got an extra good breakfast and I

Don't put a piece of work in a vise to make centerpunch marks, or stamp steel figures on it, but lay it flat on a good solid bench-block.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1906.

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* * *

Two miles in 58 4-5 seconds by the 200 H. P. French Darracq car; and one mile in 28 1-5 seconds by the 50 H. P. American Stanley steamer. These are the records of this year's races at the Ormond-Datona beach, eclipsing all previous efforts to get over the ground by means of a motor-driven vehicle. But what of it? It is creditable to our manufacturers that materials and workmanship have reached so high a degree of perfection that a machine will stand the strain of such a contest—more creditable than that thousands of people take delight in watching foolhardy adventurers risk their lives in driving the machines in this phenomenal time. But nevertheless such contests are of no value to the manufacturer and in no way help him to produce a car of greater utility to the general public.

* * *

A NEEDED MACHINE.

An illustration of the difficulty of making a practical machine in which the government is vitally interested is the postage stamp sticking machine. To our knowledge there is no practical machine for sticking postage stamps on letters, although the demand for such a machine is considerable. The difficulty of the problem lies in the fact that postage stamps come in sheets gummed and perforated. A postage sticking machine should, of course, have the stamps printed in strips which should not be perforated but should be slightly notched on each side at the junctions of adjacent stamps. With the stamps prepared in this manner the problem of a successful sticking machine becomes a comparatively simple one but where the invention is restricted to the use of stamps in the present form the difficulties are so great as to make the scheme in all probability impractical. To get the government officials to print stamps in strips and supply them rolled, ready for use in such a machine would require great influence and pressure and is something that would likely cause a scandal on account of appearing to favor a patented device which in the nature of the thing must be a monopoly. The solution of the problem would seem to be to assign the basic patent to the public, something after the case of the vertical plane car coupler. As is well known the McConway & Torley Co., who owned the basic patent on the vertical plane coupler, assigned it to the public so that it could be made the standard type, which could not have been done if the field had not been an open one. This firm took their chances with competitors, reserving only their minor patents which were on details not necessary to the principle of the device. With the postage sticking machine, if it could be made to appear that the basic idea was open for competition and there were a number of manufacturers making machines which differed in details only and who were competing for business, then it would seem that the way would be clear to put up the postage stamps in the desired form. It should be stated in this connection that firms mailing large quantities of matter, not first class, have the option of paying postage in bulk where the mail is sent under certain postoffice supervision and thus the use of stamps is avoided, but this does not apply to letters and other first-class matter.

* * *

NAVAL ENGINEERS BECOMING SCARCE.

Something over five years ago the "Personnel Bill" went into effect, by which the engineering corps of the navy was abolished and engineers were to become officers of the line, or officers of the line were also to become engineers, as the case might be. In other words, it now devolves upon an officer or engineer of the navy to become proficient in seamanship, in gunnery and in engineering, the latter not only including the care and operation of marine machinery but its design and construction as well.

Engineer-in-Chief C. W. Rae of the U. S. Navy states in his annual report that owing to the absence of specific instructions in the Personnel Bill, combined with "powerful adverse influences," absolutely nothing has been done by the younger officers of the line in acquiring engineering experience. He therefore sounds the note of alarm and says that with the diminishing of the number of older men of the engineering corps the country is approaching a state where it would be in no condition to win battles in war. Our guns cannot be carried to the firing line and kept there witth amateurs in charge of the machinery, and no officer out of the academy a short time, who would not even be given charge of the deck except under the supervision of his senior officer, should be placed in charge of the engineering of a ship as has been done.

The Personnel Bill has been the target for frequent bombardment by the press, and Chief Rae feels called upon to defend it, although he suggests needed modifications in its workings. He contends that engineering as applied to the propulsion of ships logically belongs to the line and the main reasons for this opinion appear to be that there are not enough positions of high rank to secure proper promotion of two sets of officers—the engineers, and the officers of the line; that there are controversies and jealousies where there are two bodies of officers performing duties on shipboard; and that there is a widespread prejudice throughout the service against the formation of a separate corps of engineering specialists.

In common with many others not connected with navy, but who are more or less acquainted witn human nature, we think the "jealousies" and "widespread prejudice" have been more influential in bringing about the new order of things than has common-sense judgment. Some may make good sailors, proficient engineers, expert gunners and capable machine designers in the time ascribed to the allotted age of man, but men who can do this are scarce.

* * *

Where the flywheel of a steam or gas engine is made with curved spokes it should be mounted on the crankshaft so that the outer curve of the spokes is backward. This puts the iron of the spokes in compression in transmitting the power developed in the cylinder. If the flywheel be put on in the reverse position with the outer curve of the spokes forward the spokes are put in tension in transmitting the power; this is not good practice in cast iron construction although in the case of the flywheel the rim is always in tension, due to the centrifugal stress, but it is unavoidable. Placing the wheel as directed increases the stress in the flywheel rim because of the reaction of the spokes. The rim, however, is always made much heavier and stronger than the spokes and, moreover, is not so likely to be weakened by casting strains.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

According to a statement in the *Horseless Age* the practice of slightly offsetting the center line of gasoline engine cylinders with respect to the axis of the crankshaft has been adopted by a number of the leading French automobile manufacturers. This practice, it is said, originated with the Westinghouse Machine Co. in 1886 when they first placed on the market their two-cylinder, high-speed, single-acting steam engine fitted with trunk pistons. The result of offsetting the cylinder is that the side pressure of the piston on the cylinder wall due to the thrust of the connecting-rod is decreased during the power stroke and increased during the compression stroke, but as the compression pressure is much lower than the expansion pressure the increase of side pressure during the compression stroke is less important than the decrease of side pressure during the expansion stroke. Consequently the cylinder wear should be decreased.

The time switch is an electrical device that has been found useful for automatically switching on the lights in show windows, says the *Electrical Age*. The clock governing the switches can be set so that a sign or show window would be lighted at a predetermined time and after burning for the desired period would be automatically switched off. An extension of this scheme that might not be unprofitable in some cases would be the lighting of offices, drawing rooms and even shops. There is a tendency, as is well-known, for men when absorbed in their work to continue working without sufficient light and until some one realizes the lack of light there may be a number of workers suffering from eye strain. With the automatic time switch the lights would be turned on at a certain time each day. The serious drawback to such a scheme is that in the winter months when light is most needed the time for lighting changes each day for the same weather conditions, and changes in the weather make the time for lighting up very irregular.

In a recent bulletin issued by the B. F. Sturtevant Co., Boston, Mass., is listed a series of "gas boosters" manufactured by them which serve the very useful purpose of increasing the pressure of illuminating or fuel gas in gas mains. While the arrangement is very simple it is one that probably not all of our readers are familiar with. A valve is placed in the gas main and a by-pass is connected, leading around from one side of the valve to the other. The booster, which is a special form of rotary exhaust fan, is placed in the by-pass and draws gas from the supply on one side of the stop valve and delivers it to the other side at an increased pressure. It is stated that the light obtained from the burners supplied by gas delivered by the blower is perfectly steady and that the light is not distinguishable from that coming from a burner fed by gas delivered by the regular gas-holder pressure. This method of pressure boosting is applicable in the localities where the consumption has outgrown the capacity of the pipes or in hilly towns where low-lying districts fail to get sufficient pressure. It also overcomes the resistance caused by frost in pipes, and in manufacturing plants the pressure may be increased to offset the effect of small pipes or to supply gas furnaces, brazing tools, testing laboratories, etc. It apparently simplifies the problem of employing gas as a fuel, which is having an ever widening field of usefulness.

The steam turbine marked a great step forward in our type of prime mover, giving much needed relief from the limitations of reciprocating engine practice. Engineers are now finding that, apart from its merit as a prime mover, its effect on power plant design will be far-reaching in the direction of simplicity and reduction of original cost. So far, turbines have, as a rule, been installed in power plants more or less conventionally designed on the lines of piston engine practice, but we will soon have typical turbine plants, with their various other features and general arrangement co-ordinated to the simplicity and compactness of turbine design, and much of the present-day complexity, with its attending expense, will disappear. Two plants are now being designed—one for Fort Wayne, Ind., the other for Hamilton, Ohio—in which this general idea will be carried out. The boilers will be on the ground floor, and the turbine located directly overhead; thus the steam and exhaust runs will be short and direct, the initial steam coming up and the exhaust going down, as they should. The exciters are put on the generator shaft, thus eliminating separate exciting units; in fact, the stations will contain as little in the way of auxiliaries as possible. There will be some saving in building construction, considerable saving in ground space, and it would not be surprising if the whole station, including ground, were to show a reduction in first cost per kilowatt of 25 per cent on the usual capital account of such properties.—*Edward H. Sniffin in Electric Journal.*

The details of an interesting test of a Curtis steam turbine are given in the January, 1906, issue of *Power*. The turbine was a 500-kilowatt capacity and was installed in the Oshkosh, Wis., Gas Light Co.'s plant. The following tabulated data gives the economy at various loads of the final test.

Half load, 250 kw.—25.99 lbs. steam per kw.-h.:

Average barometer	29.40 in.
Average vacuum	26.79 in.
Average initial steam pressure	150.00 lb.
Average quality of steam	98.20 %

Full load, 499 kw.—22.64 lbs. steam per kw.-h.:

Average barometer	28.97 in.
Average vacuum	26.40 in.
Average initial steam pressure	141.75 lb.
Average quality of steam	98.20 %

Overload, 22.2%, 611 kw.—22.28 lbs. steam per kw.-h.

Average barometer	29.01 in.
Average vacuum	26.40 in.
Average initial steam pressure	142.20 lb.
Average quality of steam	98.20 %

Commercial run, average real kw., 262.7—26.34 lbs. steam per kw.h.:

Average barometer	29.24 in.
Average vacuum	26.29 in.
Average initial steam pressure	146.00 lb.
Average quality of steam	98.20 %

The above results are corrected for step-bearing overflow and condenser leakage.

The one-half, full and 122.2% loads are rheostatic and non-inductive and measured at the switchboard.

RAPID WEAR OF MODERN GUNS.

Annual Report of Brig. Gen. Wm. Cozier, Chief of Ordnance.

Accompanying the use of the larger charges of powder there was introduced a new element limiting the life of guns, namely, that of erosion of the bore. This was very great in the neighborhood of the seat of the projectile, and very decided in its action, scoring and guttering the surface in a manner which required its renewal after a certain number of rounds. The life fixed by this process, however, was not unreasonably short, a 10-inch gun being capable of enduring from 250 to 300 rounds before requiring relining, so that the question of limiting the power because of this difficulty was scarcely considered. With the general use of smokeless powder, however, with its still better control of the rate of burning, and the great increase in the powder charges and in the velocity, the subject of the wear of the bore has greatly increased in importance. This wear is of a different kind from that described above, being unaccompanied by the deep guttering of the surface which was experienced with the powder immediately preceding, but the smooth and even wearing away of the surface proceeds with such rapidity that after some 50 or 60 rounds from large guns the rifling is so worn away that the projectiles are no longer given the motion of rotation necessary to steadiness of flight, and inadmissible loss of accuracy results. There has, therefore, been brought about a serious consideration of the question whether the guns should not be used at a power less than that which their strength enables the realization of, in order to diminish the erosion and increase the life.

THE WORKS OF AN AXE.

Could the city dweller, says "Backwoods" in the *Woodworker*, who knows the axe only as an implement for reducing packing boxes to kindling wood, and who handles it with but little more dexterity than does his wife, take a tramp in the backwoods—the way-backwoods—he would see much that would cause him to wonder at the works of that little-esteemed tool.

Many a residence is built and furnished with no other tool, except maybe a pocket knife for the finer work; while the addition of an auger to the kit enables the builder to indulge in luxuries. More than one mid-winter night has the writer spent most comfortably in a house and on furniture, which bore the marks of no other tool, unless one designate as a tool the large nail which was used to burn the holes in the wooden hinges of "the big front door."

The pioneer who "blazes the trails," travels light; and, when he builds a residence miles from any road over which a horse could be urged, which is to serve till he is "crowded out"

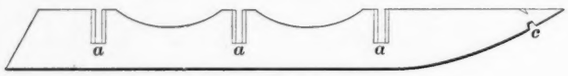
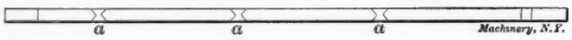


Fig. 1



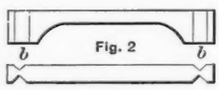


Fig. 2

by a neighbor within a mile or two on either side, well nigh all his wants must be supplied by the axe alone. While it wouldn't be good form to say so in a story, yet in real life it is a fact that more of his food wants are supplied through traps and snares made with an axe, than are by his rifle; and, be it a candlestick, a washbasin or a bedstead, he meets the want from the natural growth around him, wrought with this one omniferous tool.

It was at one of these country residences that the writer saw a practicable hand sled, axe-made, the parts of which are shown in plan and side views in the accompanying sketch. Fig. 1 shows the runners, split and hewn from straight-grained birch, with the notches *a a a* cut so that the bunks shown in Fig. 2, notched as shown at *b*, will fit snugly therein. No nail, screw, bolt nor any metal part was there; the bunks were simply dropped into place, a rope of leatherwood bark tied in the notches *c*, and the vehicle was ready to load.

The six-cylinder gasoline engine built by the Wolseley Tool & Motor Car Company, of Birmingham, England, for railway motor cars has taken on an additional interest to Americans on account of its contemplated use by the Delaware & Hudson Co. in their new motor car being built by the General Electric Co. at Schenectady, N. Y. The Wolseley engines have been used with much success by the North-Eastern Railway Co. on a type of motor car wherein a gasoline engine is used to drive a generator which furnishes current for the motors driving the car. The engine, which is to be used by the Delaware & Hudson Co., is built with horizontal cylinders, three opposing cylinders being on each side of the crankshaft. The opposing cylinders are not directly in line but are offset the width of the crank, by which construction each pair of pistons are always moving in opposite directions, thus giving perfect balancing. The cylinders are 9 inches diameter and 10 inches stroke and the flywheel weighs 780 pounds. The practice of the North Eastern Railway in regard to starting has been to use electric accumulators, but the new engine for the Delaware & Hudson Co. is to be started by the explosion of cartridges in the engine cylinders. A special breach mechanism is provided and cartridges of ordinary sporting size containing from 280 to 300 grains of black powder are found to give a cylinder pressure of about half the ordinary working pressure. These cartridges are successively exploded by special mechanism in conjunction with the timing gear for the usual electric ignition. Three cartridges only are employed in as many cylinders for starting, the other three cylinders drawing in charges the same as under working conditions so that the initial movement communicated by the explosion of the cartridges is at once taken up by the working cylinders which go into regular operation. For the details enumerated in the foregoing we are indebted to the November 10, 1905, issue of *Engineering*.

EFFECT OF RAPID CHANGES IN THE VELOCITY OF WATER.

A report has recently been published by the British Engine, Boiler and Electrical Insurance Co., Ltd., in which are described a number of peculiar accidents and breakdowns that have occurred in connection with steam and gas engines. One incident was in connection with a pump which delivered water through a three-inch pipe to a tank 38 feet above the pump. One day it was noticed that the valve chamber of the pump was cracked and the explanation apparently was that the force required to accelerate the column of water in the discharge pipe on the opening of the delivery valves was great enough to have done the damage, particularly if the pump were discharging at only a part of its capacity, so that between the intervals of discharge the water in the vertical pipe would lose its upward velocity. A calculation made by the writer of the report indicates that the pressure might have been between 900 and 1,000 pounds per square inch from this cause. The speed of the pump was such that the water in the discharge pipe had been accelerated to a velocity 48.6 feet per second with the discharge valve open, while it is estimated that before the valve opened the velocity must have been less than 31 feet per second. Therefore, at the moment of opening the delivery valve the velocity of the 116 pounds of water in the pipe had to be increased in a very short period of time at least from 31 feet per second to 48.6 feet per second. The length of time available for affecting this increase would depend on the leakage past the piston, but if the time were 0.01 second, the force required to change the velocity would equal 925 pounds per square inch. While these figures are not known to be correct, they show that rapid changes of the velocities of water cannot be effected without producing very great pressure.

The magnitude of the forces required to put long columns of water into motion in short spaces of time are often much underestimated. This remark may be illustrated by a case which came under the notice of one of the company's inspectors. A steam pump single acting, with a plunger 1 9/16 inch diameter by 4¾ inch stroke, running about 62 revolutions per minute, received its supply from a tank through a 1-inch lead pipe 3 feet long leading vertically downward from the bottom of the tank, and coupled at the bottom by a union to a wrought-iron elbow carried vertically downward for 12 inches, and then horizontally for 2 feet to the suction valves of the pump. The water level in the tank was 2 feet 3 inches above the bottom, and, therefore, 5 feet 3 inches above the union connecting the lead to the wrought-iron pipe. The pump had been running practically day and night for 14 years, during which time the lead pipe had gradually bulged out into a globular shape just above the union, and finally it burst. The bulging was due to the pressure set up by the stoppage of the flow when the suction valve closed.

PORTABLE HAND SHAPER OR PLANING MACHINE.

In a recent issue of the *Practical Engineer* a novel hand planing machine was illustrated and described which can be mounted in a bench vise, being clamped with the work, and in this position the work may be planed off by reciprocating the tool head by means of a lever, as is shown in Fig. 2.

As will be seen from Fig. 1, the apparatus consists practically of two parts, the lower part *a* representing a semi-cylindrical trough, the longitudinal edges of which are the guides for the slide *c*, and of the ram *b*, holding the planing tool. The ram *b* is moved backward and forward by means of a lever, and the feed is effected either by hand or automatically. For the purpose of working it automatically there is a rectangular slot *u* through which a star-shaped wheel *o*

passes, which acts as a nut to the leading screw *s*. Underneath the opening *u* two jaws *v* are provided, with smooth holes for the screw *s*, and between which the wheel *o* is held. As the leading screw *s* is prevented from moving longitudinally by a nut, the wheel *o*, when turning, will move in the direction of the longitudinal axis of the leading screw *s*, and carry with it the intermediate slider *c*, by pressing against one of the jaws *v*. In order to turn the wheel *o* use is made

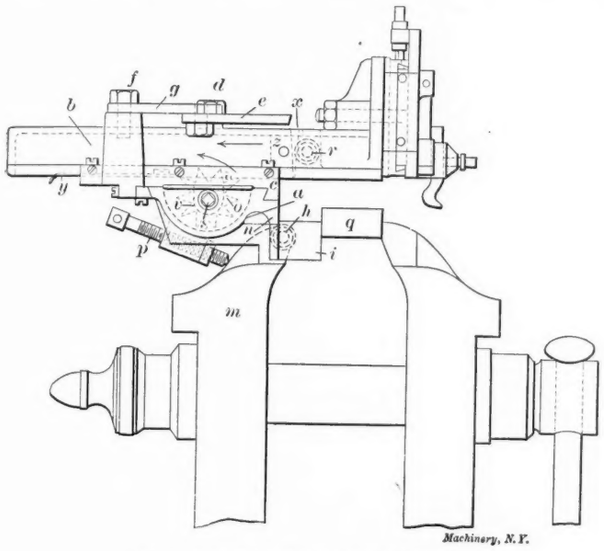


Fig. 1. Side View of Hand Planing Machine.

of the carrier *b*, inside which a swinging catch *x* is suspended, which can only swing to the left hand, whereas on the right hand it comes in contact with the stop *r*, which prevents it from swinging in that direction. On the return movement of the carrier in the direction of the arrow, the catch *x* pushes against a point of the wheel *o*, turning the latter through a certain angle, whereas in the forward movement

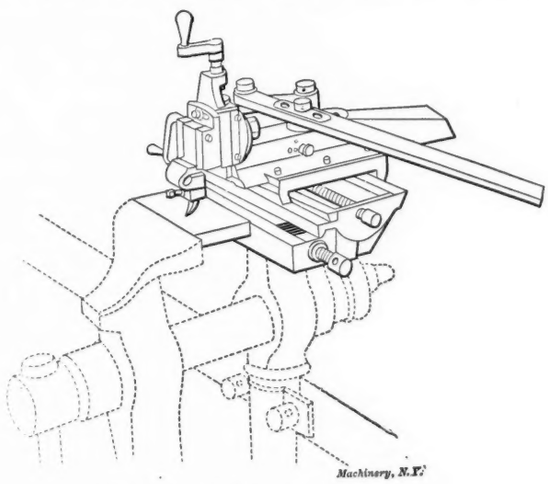


Fig. 2. The Machine at Work in the Vise.

of the carrier the catch *x* gives way in the direction of *z*, without any effect upon the wheel *o*. If the stop *r* is put in on the left hand the self-acting movement of the slide *c* is effected in the opposite direction. The tool is made by the Union Standard Machine Co., 165 Queen Victoria Street, London, E. C.

THE PROBLEM OF THE GAS TURBINE.

Robert M. Neilson, in Power, January, 1906.

The success of the steam turbine has led many engineers to expect success with turbines impelled by gaseous products of combustion. A gas engine using coal gas or producer gas, and having no reciprocating parts, would be a very desirable prime mover if it had an efficiency equal to that of existing gas engines of equal power. There are, however, formidable difficulties in the way of producing such a machine. With any gas engine, reciprocating or turbine, compression is necessary in order to obtain a good efficiency; and in reciprocating gas engines it has been found (as was to be expected from theoretical considerations) that the greater the compression, the greater the efficiency until practical developments (such as preignition) come in to prevent higher compression. Now the higher the compression, the more important is it to have efficient compression. A rotary compressor which will be efficient for high pressures is therefore necessary before an efficient wholly-rotary gas engine can be produced. Now, we do not seem to have at present a satisfactory and efficient rotary compressor which can deliver air at, say, 100 pounds per square inch. Turbine compressors, such as made by C. A. Parsons & Co., in England, have much to be said for them, but unfortunately they do not seem to be efficient for high pressures.

The heat losses in a gas turbine demand serious consideration. Steam entering a steam turbine, even with a fairly high superheat, has a temperature very much below that existing in a gas-engine combustion chamber. Water-jacketing or other means are adopted in a reciprocating gas engine to keep the cylinder and other parts from getting overheated; and a certain amount of heat is thus lost which otherwise would have been converted into useful work. The gas, however, taken as a whole, is not brought into very intimate contact with the artificially-cooled parts. If, however, a mass of intensely hot gas, such as usually exists in the center of an Otto engine combustion chamber just after the beginning of the expansion stroke, were allowed to pass into a turbine, say, of the Parsons type, the blades of the turbine, even if they could be water-cooled sufficiently to stand the heat (which is doubtful in the case of some of them), would absorb such a quantity of heat energy from the gas as to leave comparatively little for conversion into useful power. The expansion of the hot gases in divergent nozzles and the mixing of them with a cooler fluid have been proposed, with a view to reducing the temperature of the gases before they reach the turbine proper.

In De Laval steam turbines, the steam before coming into contact with the turbine wheel is expanded in divergent nozzles from the initial pressure—say, 200 pounds per square inch—to approximately the exhaust pressure, which may be that of the atmosphere or of a good condenser. This expansion is done—and done very satisfactorily—in a single stage in divergent nozzles which convert the available heat energy (minus small losses due to friction, etc.) into kinetic energy. The steam issues with a very high velocity and a comparatively low temperature from the nozzles, and, entering the turbine buckets, drives the wheel. If we were to expand gaseous products of combustion in divergent nozzles the same as is done with steam in De Laval steam turbines, we could with a suitable choice of working conditions obtain a temperature at the outlet ends of the nozzles such as a turbine wheel could stand. Our knowledge of the expansion of elastic fluids, other than steam, in divergent nozzles for use with turbine wheels is, however, almost nil; and experiments must be made before we can say with confidence whether as good results may be expected with gaseous products of combustion as can be obtained with steam.

The mixture of the hot gaseous products of combustion with water before use in a turbine would allow of the temperature being very much reduced. Unless, however, the ratio of water to gas were very high, the temperature of the resultant mixture would still be too great for it to be suitable for use in a turbine unless divergent nozzles were employed to reduce the temperature still further before the mixture was allowed to come into contact with the rotating vanes.

If the proportion of added water to products of combustion were great, then the fluid would be very much like superheated steam, which always contains, in practical steam-engine work, a certain amount of air. The turbine could then be built like any of the common forms of steam turbine, and a condenser could be employed. The non-condensable gases would have to be removed by an air pump; and the power to drive this air pump, which might be very considerable, would have to be taken into consideration.

FOR GREATER ECONOMY OF THE GAS ENGINE.

The conditions affecting the economy of the internal combustion engine as well as some suggestions for the improvement of economy were reviewed in a recent issue of *Gas Power*. While the gas engine is already the most efficient prime mover known, the economy is seriously affected by the loss of heat transmitted to the walls and piston. When an explosive mixture of gas and air is burned in the cylinder the heat, save that which is used in performing work, leaves the mixture very rapidly especially in the smaller sizes and quickly appears in the water jacket or cooling flanges. A pound of gasoline vapor when burned slowly in air develops about 22,000 B.T.U., or, in other words, sufficient heat is developed to heat 22,000 pounds one degree F. Air, however, takes much less heat to raise its temperature than water so that the same quantity of gasoline would raise the temperature of about 132,000 pounds of air one degree F. The simplest way, therefore, in which a quantity of fuel may be made to do the most work is to make it heat a large quantity of air, adjusting the quantity of air in such proportion that at the temperature and pressure used the extra quantity of air would absorb all the heat otherwise wasted in the jacket. This, however, means weak mixtures, and weak mixtures are difficult to burn except under very high compression. Under high compression gasoline mixtures are likely to explode prematurely but this trouble may be avoided by compressing in two stages so that in the second stage the mixture enters the cylinder cool enough to prevent premature combustion when compressed in the power cylinder.

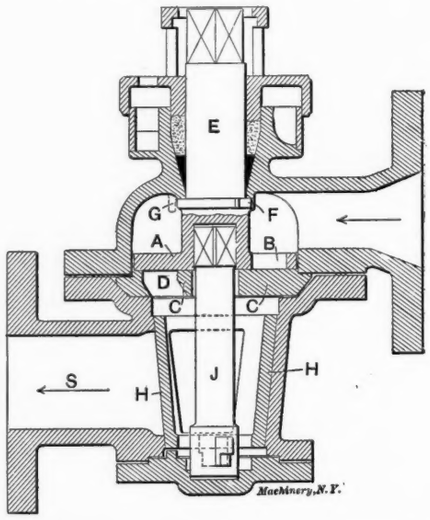
Another method which avoids the use of the air pump necessary in the foregoing requires the cylinder to be arranged so that part of the exhaust is used over again, a tank being so connected to the engine that just at the end of the working stroke when the exhaust pressure is still under 30 or 40 pounds pressure a portion of the exhaust is made to enter the tank through an automatic non-return valve. From this tank the cooled exhaust gases are admitted to the cylinder after the regular explosive charge has been drawn in. This method is open to the objection that the mixture is weakened by the introduction of the exhaust gases containing little oxygen and that a large radiating surface is required for the cooling chamber.

A third method is to inject with the regular charge a small quantity of water which will absorb the heat and generate steam. The objection to this, however, is the extreme delicacy required in regulating the quantity of water used. A very small amount is needed in the smaller sizes of gas engines and an excess will interfere with the ignition and make the action unreliable. That it is a difficult matter to regulate the quantity of water will be indicated when it is stated that in engines having say 3 x 3-inch cylinders the plunger displacement of the water pump should only be about equal to that of a cylinder 3/16 inch diameter and ¼ inch stroke, and on a 6 x 6-inch cylinder it would still be small, being only about that contained in a cylinder ⅜ inch diameter by ½ inch stroke. In short, the water injection idea seems impractical for gas engines of less than 20 H. P. There are also other practical difficulties with the water injection scheme, it may be added which militate against it.

HOPKINSON'S BOILER BLOW-OFF VALVE.

A combined disk and plug valve boiler blowoff valve is described in the *Mechanical Engineer* in which the actuating mechanism is so designed that, as soon as the plug is fully open, it remains stationary in that position until the disk valve completes its opening movement, and also remains stationary while the disk valve is closing, and not until the disk valve is fully closed does the plug or cock begin to move, the same being finally closed by the continuation of the turning movement of the valve spindle in the same direction. The advantage of this arrangement is that the packing and edges of the thoroughfares of the plug or cock and of its seat are at no time subjected to the scouring action of the liquid or fluid.

A is the valve which is subject to the pressure of the liquid, the same consisting of a rotary disk furnished with an opening *B* forming the thoroughfare and working on a seat *C*, having a similar opening *D*, which is opened and closed by turning the disk. The disk is actuated by a socket wrench or key applied to the spindle *E* and the extent of the opening movement is governed by a stop *F* on the spindle, and a corresponding stop *G* on the cover of the valve casing. In combination with the disk valve *A*, and turned by it, is a hollow plug *H*, working in a seat in the casing, and having an opening in the wall, which opening when brought into agreement with the opening *S* in the casing forms the outlet. The construction and arrangement are such that when the spindle *E* is turned for the purpose of opening the valve, the thoroughfare in the plug *H* opens first and is fully opened before the thoroughfare through the disk valve *A* begins to open and conversely when closing the valve the thoroughfare in the plug remains open until the thoroughfare in the disk valve is fully closed, so that the plug is neither being opened nor being closed while there is a flow of liquid through the casing, and the faces of the plug and seat in the casing upon which dependence is placed for securing fluid tightness are therefore not subjected to the passing currents when blowing through. The valve is made by J. Hopkinson & Co., Huddersfield, Eng.



EARLY HISTORY OF STEAM WARMING AND VENTILATING IN AMERICA.

R. T. Crane, in the Valve World.

The history of heating and ventilating engineering in this country commences with Joseph Nason, who, upon his return from England in the latter part of 1842, began the introduction into this country of the Perkins system of hot-water heating, with which Mr. Nason was thoroughly familiar, having been for some years, while in England, in the employ of Mr. Perkins. Mr. Nason and his brother-in-law, James J. Walworth, formed a partnership and bought out the New York agency of John Russell & Sons, well-known English manufacturers of buttweld pipe. Shortly after Mr. Nason's return to this country, it was decided that Boston would be a better location than New York, so the firm moved to that city. A short time afterward several orders for heating apparatus were received; among them, a contract was secured for warming the counting-room of the Middlesex Mill, in Lowell, which was warmed by the Perkins system, and was the first heating work done in this country by Mr. Nason.

In 1845 the Eastern Exchange Hotel, East Boston, was equipped, this job being of particular interest, as in the apparatus, while steam was used as a heating medium, the surface, following the Perkins hot-water practice, was all made of three-quarter-inch pipe, and it is the first instance on record, either in this country or abroad, where small pipe was used for steam heating. During the same year a mill at Burlington, Vt., was heated by exhaust steam with three-quarter-inch pipe, which is the first instance where a mill was warmed in this manner. Previous to Mr. Nason's going into the business, several mills had been warmed by passing exhaust steam into large cast-iron pipes.

In 1846 a radical departure in the method of heating—in

this country at least—was made by the warming of the Boston custom house by means of mechanical propulsion of air. A large coil of three-quarter-inch pipe was massed in the basement, and from it to the several registers were run ducts of sufficient capacity to carry the warmed air. This plan of warming, while not new to France, was entirely novel in this country, and was the beginning of all subsequent systems in which fans were employed for distributing air. The fact that this plan of warming had already been employed in France does not detract from the credit due to Mr. Nason, as there is no evidence that while abroad he went to France, and it is highly probable that he was not familiar with the progress that had been made in that country.

In the same year the Naumkeag mill in Salem was heated with exhaust steam, the job being notable, as in the exhaust pipe was placed a back-pressure valve, which was designed for the purpose, and was the first of its kind. Heating by exhaust steam soon became well known, and was in considerable repute because of the saving effected in fuel consumption by using steam which would otherwise be wasted. All these jobs were laid out so as to throw but little back pressure on the engine.

In 1852 the partnership existing between Mr. Nason and Mr. Walworth was dissolved. Mr. Nason went to New York, taking over the firm's business in that city. The earlier work done by him in that city was largely on dwelling-houses, though many public buildings were warmed, not only in the vicinity of the city, but throughout the country.

In 1855, in which year extensive alterations of and additions to the United States Capitol at Washington were in progress, Mr. Nason, at the request of Gen. Meigs, then in charge there, went to Washington and planned a system of ventilating and heating for the Capitol. This was the first really scientific and complete job of the kind done in this country. Mr. Nason, as this job at the Capitol shows, had a thorough knowledge of the business as it was then known, and was at the time unquestionably the best informed and most experienced person on heating and ventilating in the United States.

The apparatus installed under Mr. Nason's direction consisted primarily of a heating surface of wrought-iron pipe, over which air was forced by means of two specially designed centrifugal fans, and conducted through ducts to the rooms to be heated and ventilated. It will be remembered that both the halls of Congress are inside rooms surrounded by corridors and rooms. Inasmuch as the warmed corridors and rooms protected the meeting halls from the cold, it was not necessary to warm the halls, consequently air was introduced at a temperature of 70 degrees. So far as we know, this is the only case of the kind that ever occurred.

In order to meet these conditions, the heating surface was massed in at least two sections, one section being used for heating the air intended solely for ventilating purposes, another section being used for heating air intended for warming purposes.

This plan of having a large amount of heating surface located in one place and the air blown through it, the heated air being then conducted to such places as it was needed, was for some years the favorite mode of heating. Some years after a job of this kind was put in the new post office at Washington. It was also placed in several insane asylums. It was soon abandoned, however, for the distributing plan of heating surface as now universally carried out.

In this connection I would mention an incident that occurred about the year 1855, which, while not connected with heating engineering, brings out a fundamental business principle which has always been impressed upon my mind. Senator Floyd, of Virginia, was at the head of the committee in charge of the post-office job, and he insisted on letting the contract to a firm in Richmond that was not in this line of business. General Meigs, a man of great engineering ability and integrity, vigorously protested against Mr. Floyd's action in this matter, and wanted the contract placed with the only person in this country who had had experience and shown ability in this line of work, namely, Mr. Nason of New York.

Before leaving the Capitol, in connection with the lighting and ventilation, a matter which had much to do with the comfort of the halls of Congress might be mentioned as illustrating the good judgment used in arranging the halls. Whether Mr. Nason or General Meigs was personally in charge of this work we do not know. In order to prevent the gas lights (gas was then used for lighting the halls) from vitiating the air of the rooms, they were placed above the glass ceilings. In this way the combustion of the gas did not interfere with the perfect ventilation of the halls. One of the peculiarities of the system was the method of igniting the gas, which was made necessary by the fact that the jets were distributed over the entire ceiling, and consequently could not be lighted by hand, and they were so far apart they would not ignite from each other. To meet the situation, the engineer in charge ran an extra gas pipe over the ceiling, on which pipe the jets were so close together that when one was lighted the flame would run the length of the pipe. These smaller jets were so located in reference to the regular burners that when the gas was turned on the main line each burner was lighted. Then, of course, the gas was turned off the igniting system.

This recalls a rather unique method of lighting inaccessible burners I saw in Berlin. A row of jets was located in the dome of an arcade. A little wagon, equipped with propelling machinery, ran around a track, carrying a torch to the burners.

POWER PLANT ECONOMICS.

Abstract of Paper read before the American Institute of Electrical Engineers by Henry G. Stott, Superintendent of Motive Power, Interborough Rapid Transit Co., New York.

The development of the steam turbine during the past three years has resulted in marked changes and improvement in power plant engineering as a whole. The superheater has been revived and so developed that superheat of 200 deg. or 300 deg. is feasible. With the study of the superheater question has come increased attention to the furnace, which will probably be still further improved. Another important result has been the development of condensing apparatus to such a point of efficiency that a vacuum within one inch of the simultaneous barometer reading can now be maintained without difficulty. Another change has been the reversion to high-speed generators, resulting in decreased cost of the generator and its foundations, as well as a saving in floor space. And last but not least the steam turbine has put the reciprocating engine and the gas engine on the defensive and has actually been unkind enough to throw out hints in regard to the application of Dr. Osler's proposed methods to the treatment of older apparatus.

The reciprocating engine and internal-combustion engine have not been slow in accepting this challenge; they have responded by showing so improved an economy (especially in the gas engine) that the situation has become most interesting to the power-plant designer. It is safe to say that the developments of the next ten years will show very marked improvement in power-plant efficiency.

In Table 1 will be found a complete analysis of the losses found in a year's operation of what is probably one of the most efficient plants in existence to-day and, therefore, typical of the present state of the art.

TABLE 1. ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL INTO ELECTRICITY.

	B. T. U.	Per Cent.
1. B.T.U. per pound of coal supplied*	14,150	100
2. Loss in ashes	340	2.4
3. Loss to stack	3,212	22.7
4. Loss in boiler radiation and leakage	1,131	8.0
5. Returned by feed-water heater*	441	3.1
6. Returned by economizer*	960	6.8
7. Loss in pipe radiation	28	0.2
8. Delivered to circulator	223	1.6
9. Delivered to feed-pump	203	1.4
10. Loss in leakage and high-pressure drips	152	1.1
11. Delivered to small auxiliaries	51	0.4
12. Heating	31	0.2
13. Loss in engine friction	111	0.8
14. Electrical losses	36	0.3
15. Engine radiation losses	28	0.2
16. Rejected to condenser	8,524	60.1
17. To house auxiliaries	29	0.2
Total except items marked *	14,099	99.6
Total of items marked *	15,551	109.9
Delivered to bus-bar	1,452	10.3

In regard to this development the author wishes to direct attention to the basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyze the entire plant from the coal to the bus-bars; first, in regard to efficiency; secondly, in regard to the effect of load-factor upon investment; and thirdly, the effect of the first and second upon the total cost of producing the kilowatt-hour, which is the ultimate test of the skill of the designer and operator.

Mr. Stott discusses at length the various items in the above table, and reference to a few of the important points brought out will be made. The thermal value of the coal used is evidently of prime importance, as it affects the cost efficiency of the entire plant. The method of purchasing coal used in the plant from which this heat balance is derived is that of paying for B. T. U. only, with suitable restrictions on the maximum permissible amount of volatile matter, ash, and sulphur. A small sample of coal is automatically taken from each filling the weighing hoppers, so that the final sample represents a true average of a boat-load of coal. This final average sample is then pulverized and tested for heat value in a bomb calorimeter, after which a proximate analysis is made of another portion of the sample. This method of purchasing coal has been in use for two years, with highly satisfactory results. The loss to the stack is one of the most vulnerable points of attack as the loss of 22.7 per cent is very large. Recent investigations show that promising results may be obtained by the use of more scientific methods in the boiler room. In practically all cases it will be found that this loss is due almost entirely to admitting too much air to the combustion chamber, resulting in cooling of the furnace. This result is usually produced by "holes" in the fire; these "holes" may be due to several causes, but usually are due to carelessness on the part of the fireman.

Fortunately, a very valuable piece of apparatus in the way of a CO_2 recording gage is now to be had, which shows the condition of the gases in the chimney and enables us to know when the furnace is operating properly.

The loss in boiler radiation and leakage, amounting to 8 per cent in the table, is largely due to the inefficient boiler setting of brick which, besides permitting radiation, admits a large amount of air by infiltration. This infiltration will increase with the draught, thus tending to exaggerate the maximum and minimum points on Fig. 6. The remedy for this radiation and infiltration loss is evidently to use new methods of boiler setting, such as an iron plate air-tight case inclosing a carbonate of magnesia lining outside the brickwork.

Mr. W. H. Patchell, of London (see paper read Dec. 7, 1905, before the Institution of Electrical Engineers), has introduced very large boilers, assembling two in one setting; each boiler has a normal evaporation of 33,000 pounds per hour and in this way has cut down to a minimum the radiating surface per square foot of heating surface. He has also introduced the iron case with magnesia lining, and with good results.

The question of boiler leakage is one in which the choice of the lesser of two evils is necessary; for in the tubular or cylindrical boiler the leakage will undoubtedly be less than in the water-tube type, owing to the smaller number of joints in the water space. But these two advantages are offset by the increased difficulty of construction, and the danger of using large boilers of the tubular type, with high-pressure steam.

It is now generally admitted that there can be no more difference in the efficiency of different types of boilers under similar conditions than there can be in electric heaters, press agents to the contrary notwithstanding.

We will now take up certain of the items of Table I in detail.

Item 6. Owing to the difficulty of pumping water at temperatures above 150 degrees Fahr., when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed-water temperature to 200 or 250 degrees Fahr. As this increase of temperature is obtained from the waste gases at no expense for fuel, it only becomes necessary to consider the load-factor, as will be shown later, in order to decide whether economizers should be installed or not. In practically all cases where the load factor exceeds 25 per cent the investment will be justified.

In deciding upon the size of economizer to be installed it is important to consider first, the influence of the economizer upon the available draught due to the obstruction it offers and also due to the reduced stack temperature; the second important consideration is to equate the interest and depreciation charges against the saving in fuel, and so determine the amount of investment justified in each particular case.

Items 8 and 9. Heat Delivered to Circulating and Boiler-Feed Pumps. As these auxiliaries may be either electrically driven or steam driven it is interesting to note that the thermal efficiency of the electrically-driven pumps would be equal to the thermal efficiency of the plant, multiplied by both the efficiency of conversion from the alternating to direct current and by the motor efficiency. In this case, there would be a net thermal efficiency of $10.3 \times 0.93 \times 0.90 = 8.63$ per cent, whereas the thermal efficiency of the steam-driven auxiliary discharging its exhaust into a feed-water heater at atmospheric pressure would be approximately 87 per cent.

Item 13. Loss in Engine Friction. Recent tests of a 7,500 horse power reciprocating engine show a mechanical efficiency of 93.65 per cent at full load, or an engine friction of 6.35 per cent. As this forms only 0.8 per cent of the total thermal losses it is relatively unimportant. Attention is called to the method of lubricating all the principal bearings by what is known as the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units; after passing through the bearings the oil is returned by gravity to oil filters in the basement and then pumped up to the reservoir tanks again. About 200 gallons per hour are put through each engine, and of this quantity only about 0.5 per cent is lost. This method of oiling undoubtedly contributes to the general result.

Item 14. As large electrical generators can now be obtained which give from 98 to 98.5 per cent efficiency, it would seem as if the limit in design had been reached and that hereafter the problem of design is to be merely one of altering dimensions to suit varying sizes and speeds. While this is true as far as the efficiency is concerned, other problems are continually arising, such as the design of generators for an overload capacity of 100 per cent to meet the demand for apparatus capable of taking care of great overloads economically for short periods, corresponding to peak loads of a railroad or lighting plant.

In Fig. 1 is a diagram of steam consumption per K. W. hour of a 7,500 H. P. Allis combined vertical and horizontal compound engine of the Allis type. In Fig. 2 is a typical economy curve of a steam turbine. An inspection of this curve, which represents what is probably the best results obtained up to date, shows: first, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine in Fig. 1; secondly, that 200 degrees superheat reduces the steam consumption 13.5 per cent. But calculating the total heat units in superheat from $H_1 = H + 0.48\ (t_2 - t_1)$ the B T. U. per kilowatt-hour are 20,349 for dry saturated steam, whilst for 200 degrees superheat they are 19,008 or a net thermal saving of 6.6 per cent. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo unit would be considerably better than that of the reciprocating engine, with the other great advantage of costing approximately 33 per cent less for the combined steam motor and electric generator.

Reciprocating Engine with Turbine using Exhaust Steam.

The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high pressure where relatively it is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

The following calculations show approximately what might

be expected from such a combination. Assuming that the 5,000-K. W. reciprocating unit would take 50 per cent more steam when operating non-condensing than when condensing there would then be (see Fig. 1) a consumption per kilowatt-hour of 25.5 pounds.

Steam expanding between the absolute pressure of 190 lb. and 14.7 lb. would give up 165.3 B. T. U. per lb., or a total of 4,215 B. T. U. per kilowatt-hour.

The total heat in the steam at 190 lb. absolute is 1,197, so that the heat units left for the turbine would be

$$(1{,}197 \times 25.5 - 4{,}215) \times 5{,}000 = 131{,}542{,}500 \text{ B. T. U.}$$

The B. T. U. per kilowatt-hour for a turbine unit operating on a dry saturated steam (see Fig. 2) were 20,349, but owing to the wetness of the steam at atmospheric pressure the efficiency of the turbine would in all probability be reduced to about 70

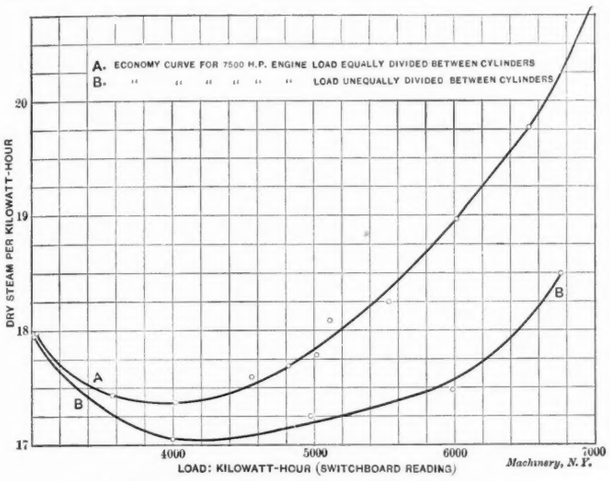


Fig. 1. Economy Curves of Allis Vertical-horizontal Engine.

per cent so that the steam consumption of the low-pressure turbine would be increased to 29,070 B. T. U. The total power, available from the turbo generator would then be 4,807 K. W.

We thus find that for a total of 152,617,500 B. T. U. we now get 5,000 K. W. from the reciprocating unit and 4,807 K. W. from the turbo unit or a total of 9,807 K. W. at a cost of 15,562 B. T. U. per kilowatt-hour.

This turbo unit would be interposed directly between the exhaust nozzle of the reciprocating engine and the condenser, and would have no valves or governing mechanism whatever. The generator would be connected directly to the other generator leads without any switching apparatus, except possibly knife switches to disconnect for testing purposes; and in operation no attention whatever would be required beyond the ordinary lubrication of bearings. Such a unit it is evident could be built at a very small cost per kilowatt.

The Internal Combustion Engine.

The gas engine has probably developed more slowly than any other piece of modern apparatus, as it is now thirty years since the Otto gas engine was introduced. It is only within the last ten years that the larger type of engine, from 500 to 2,000 H. P. in size, has appeared. The delay in bringing forward the most efficient motive power known is chiefly due to the difficulty experienced in developing an efficient and inexpensive method of making gas. As far as the production of gas from anthracite and non-caking bituminous coal is concerned this problem has apparently been solved, but it is still in a more or less unsolved condition for the richer bituminous and semi-bituminous caking coals of the Eastern States.

The great objection to the use of the gas engine for electrical purposes has been: first, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

The total investment for a gas producer plant, all auxiliaries, gas engines, and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

The accompanying heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL CONTAINING 12,500 B. T. U. INTO ELECTRICITY.

	B.T.U.	Per Cent.
Loss in gas producer and auxiliaries	2,500	20.
Loss in cooling water in jackets	2,375	19.
Loss in exhaust gases	3,750	30.
Loss in engine friction	813	6.5
Loss in electric generator	62	0.5
Total losses	9,500	76.0
Converted into electrical energy	3,000	24.0
	12,500	100.0

Where natural gas or blast-furnace gas can be obtained the gas engine has outdistanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer-gas plants, it is safe to say that rapid developments will result.

The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that its range of economical load is practically limited to between 50 per cent load and full load. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage battery of comparatively large capacity.

New Type of Plant.

Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem; for the turbine immediately proceeded to act like an ideal storage battery; that is, a storage battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam

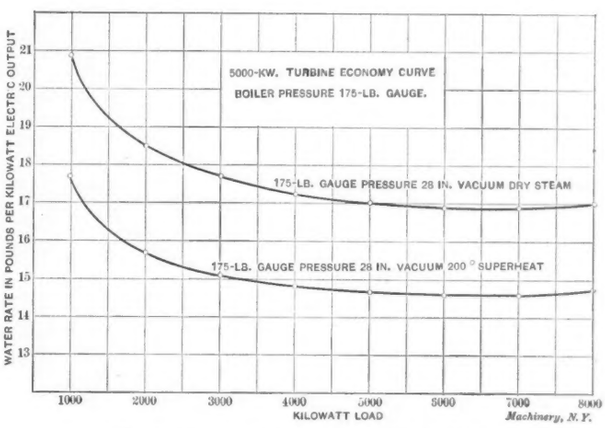


Fig. 2. Economy Curves of 5000 K.W. Turbine.

turbine, and the reciprocating units went on carrying almost constant load, whilst the turbine load fluctuated between 0 and 8,000 K. W. in periods of less than 10 seconds.

The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency whilst at the same time removing the only valid objection to the gas engine.

A steam-turbine unit can easily be designed to take care of 100 per cent overload for a few seconds; and as the load fluctuations in any plant will probably not average more than 25 per cent, with a maximum of 50 per cent for a few seconds, it would seem that if a plant were designed to operate normally with 50 per cent of its capacity in gas engines and 50 per cent in steam turbines, any fluctuations of load likely to arise in practice could be taken care of.

We have seen that the thermal losses in the gas-engine jacket-water amounted to approximately 19 per cent, and as

the water is discharged at a temperature above 100 deg. it can be used to advantage for boiler feed. Mr. Stott estimates and gives figures to show that the total average thermal efficiency of such a plant would be 24.5 per cent.

TABLE 2. DISTRIBUTION OF MAINTENANCE AND OPEARATION. CHARGES PER KILOWATT HOUR.

	Reciprocating Engines.	Steam Turbines.	Reciprocating Engines and Steam Turbines.	Gas Engine Plant.	Gas Engines and Steam Turbines.
MAINTENANCE.					
Engine room mechanical....	2.57	0.51	1.54	2.57	1.54
Boiler room or producer room	4.61	4.30	3.52	1.15	1.95
Coal and ash handling apparatus	0.58	0.54	0.44	0.29	0.29
Electrical apparatus.....	1.12	1.12	1.12	1.12	1.12
OPERATION.					
Coal and ash handling labor	2,26	2,11	1.74	1.13	1.13
Removal of ashes.....	1.06	0.94	0.80	0.53	0.53
Dock rental.....	0.74	0.74	0.74	0.74	0.74
Boiler-room labor.....	7.15	6.68	5.46	1.79	3.03
Boiler-room oil, waste, etc...	0.17	0.17	0.17	0.17	0.17
Coal	61.30	57.30	46.87	26.31	25.77
Water	7.14	0.71	5.46	3.57	2.14
Engine room mechanical labor	6.71	1.35	4.03	6.71	4.03
Lubrication	1.77	0.35	1.01	1.77	1.06
Waste, etc.....	0.30	0.30	0.30	0.30	0.30
Electrical labor.....	2.52	2,52	2.52	2.52	2.52
Relative cost of maintenance and operation.....100.00		79.64	75,12	50.67	46.32
Relative investment in per cent. 100.00		82.50	77.00	100.00	91.20

In Table 2 will be found a tabulation of the relative values of the various items necessary in the maintenance and operation of a power plant. The first column covers a plant with compound condensing reciprocating engines without superheat, and is derived from a year's record of actual costs of a large plant operating with a load-factor in this case being defined as actual output divided by 24 times the maximum hour's load.

The values in the other columns have in the main been estimated from the first column, but wherever possible actual data derived from various sources, both domestic and foreign, have been used; but in all cases all values have been reduced so as to make them directly comparable with the first column, and with one another. The values in maintenance and operation of steam turbines are derived from actual costs.

Summary.

1. The present type of steam-power plant can be improved in efficiency about 25 per cent by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam-turbine plant has an inherent economy 20 per cent better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of causes shown in Table 2.

3. An internal-combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one-half its present cost.

TESTS OF BELT PREPARATIONS.

We have received from the Cling-Surface Co., Buffalo, N. Y,. a report of tests upon belting treated by different preparations, made by students in the laboratory of Sibley College, Cornell University. The preparations used were Cling-Surface, neats'-foot oil, and two belt dressings, one a solid and one a liquid, which are regularly manufactured as commercial articles. The names of these two dressings are not given in the report, but are designated as "X" and "Z."

Four new leather belts were secured for the experiments. These were first tested in an untreated condition, and then each belt was treated as directed by the manufacturers and run at a high speed for five hours; then laid in a warm place for thirty-six hours; then again treated and run for three hours; then tested. The neat's-foot oil belt, however, to avoid a slippery face, had no last treatment.

The following summary is condensed from the report:

Results from belt with and without Cling-Surface: The untreated belt followed the usual theory of belting, *i. e.*, increase of horse power, with an increase of initial tension. The slip and arc of contact were both steadily reduced with increase of tensions. The effects of Cling-Surface on this belt were marked. The belt was softened, and given a peculiar clinging property without being in the least degree sticky to the touch. It had an extremely high transmitting power, when the initial tension was only the weight of the belt. As tension was increased, this transmitting power decreased until passing about 10 pounds per inch of width of tension, when it increased, and at maximum initial tension the output was about the same as on the lowest tension, but at the cost of the high pressures on the bearings. The slip was in no case over 2 per cent.

The belt treated with neat's-foot oil slipped badly and transmitted less power than when untreated, and aside from pliability the results were adverse.

Of the other two belts, treated with the two belt dressings, one ran with only 2 per cent slip when placed under initial tension, but this increased rapidly and the output decreased as the belt was slackened. The other one became distinctly sticky and power was lost in pulling the belt off the pulley.

Ranking the preparations according to their percentage of horse power delivered, we find this order: 1, Cling-Surface; 2 and 3, the two dressings; 4, neat's-foot oil. Cling-Surface gave 40 per cent more power on lowest tensions than the next highest.

Before the tests were run the four materials were first subjected to chemical tests to ascertain the presence of resin, free alkali, ammonia, mineral and fatty acids. None of the first three were found in any of the materials. Dressing "Z" contained some free mineral acid. The amounts of free fatty acid found is as follows: Cling-Surface, 27-100 of one per cent; neat's-foot oil, 70-100 of 1 per cent; dressing "X," 3.5 per cent.; dressing "Z," 29.85 per cent.

* * *

The seizure, actual and contemplated, of Niagara Falls by private interests to convert it into a huge power manufactory is causing much adverse comment, although it is generally recognized by the engineering profession, at least, that such an enormous natural power should not run to waste. The sentimentalists loudly decry the loss of the scenic beauty of the gigantic cataract and another class argue that private interest should not be given rights in what belongs to the public, etc. But as concerns the first, perhaps there is a possibility of utilizing a large part of the dynamic value of the falls without losing the scenic beauty. Suppose, for example, that an apron or breast of concrete were built at the foot of the falls with its face forced in the well-known cycloid curve, or curve of swiftest descent, by which the vertical fall is converted into a horizontal direction in the manner quite commonly employed to prevent destructive washing at the foot of dams. The vertical flow of water thus having been transformed into a swiftly moving horizontal flow, power development only requires that pipes or flumes for carrying the water against an impulse water wheel be provided, and in this manner a considerable portion of its force could be converted into electric energy. The difficulties of the scheme are enormous, but it suggests the possibility of using the full power of Niagara, inefficiently, it is true, but without serious damage to the scenic grandeur.

* * *

Most of the handbooks give tables containing the area of circles, beginning with a diameter of 1. To use these tables for small diameters, expressed in hundreths or thousandths of an inch, simply prefix to the tabulated area a decimal point and as many places as the square of the fraction requires. For example suppose the area of a circle 0.035 inch in diameter is wanted. Referring to the table we find that the area of a circle 35 inches diameter is 962.11 square inches; hence the area of a circle 0.035 inch diameter is 0.00096211 square inch.

A FLYWHEEL JOB.

There has recently been cast and finished in the foundry and machine shop of H. W. Caldwell & Son Co., Chicago a single half of a large split band wheel, under conditions which make the job of unusual interest. The entire band wheel was originally made by another foundry, but in putting the wheel in place on the crankshaft of the engine, one of the halves was accidently dropped into the pit and broken. It was a planed joint wheel, and such wheels of course are always cast in separate halves, but it is unusual for one foundry to cast one half to match the other half made by some other foundry, of whose cupola mixture or practice nothing is known. Inasmuch as the order for a new half was given the Caldwell Company, they accepted it, analyzed the metal in the old half of

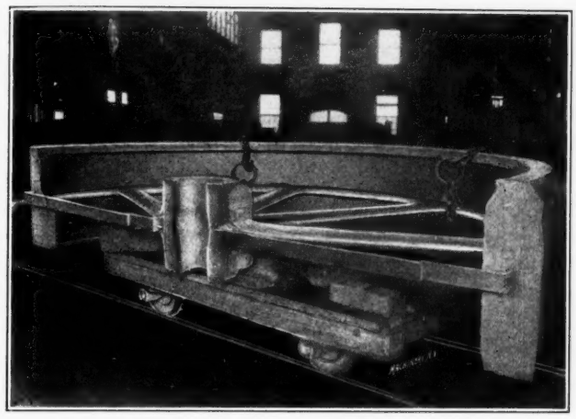


Fig. 1. The Rough Casting.

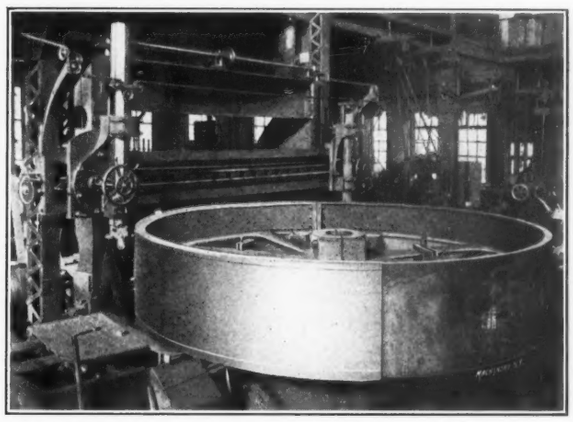


Fig. 2. Finishing the New Casting to Match the Old.

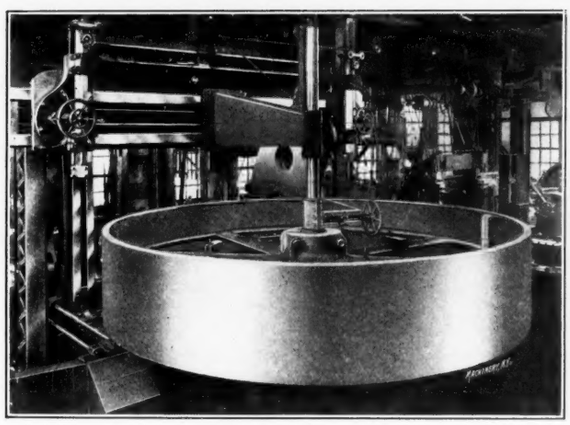


Fig. 3. Boring the Hole.

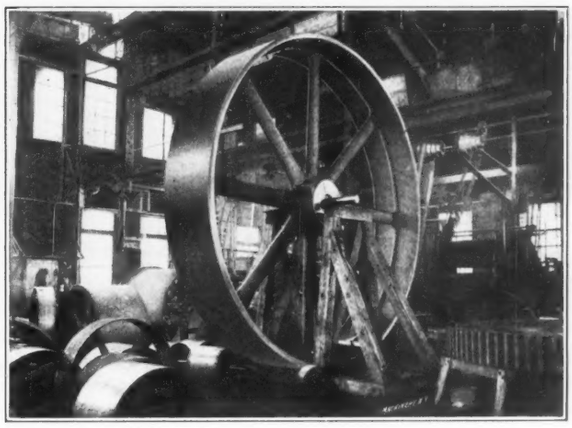


Fig. 4. Balancing the Completed Wheel.

the wheel, figured out a mixture to give the same shrinkage, moulded a new half in loam, cored out the hub and arms in the ordinary way and cast the wheel section. When the casting had been removed from the pit the first photograph was taken, Fig. 1. After the preliminary work of cleaning, chipping, drilling, facing, etc., had been done the new and old halves were bolted together on the 20-foot boring mill. Part of a cut having been taken around the face of the pulley, the second photograph, Fig. 2, was made. The darker half of the pulley, the one with the chalk marks on it, is the old half, while the other is the new part. The face of the new part was finished and the wheel arranged for the boring of the hub, as shown in Fig. 3. Fig. 4 shows the wheel with the machining operation finished and placed on the balancing ways. The remarkable part of the whole process, and that which shows the work to have been exceedingly well done, is that the finished wheel was found to be only 94 pounds out of balance, the new half being the lighter of the two. The diameter of the wheel is 18 feet, the face 42 inches, the bore 15 inches, and the weight 27,806 pounds.

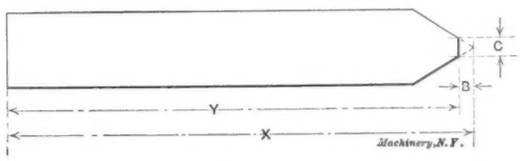
* * *

Don't always call a helper to pull the ratchet for you or to lift things that you can lift yourself.

MAKING ACCURATE THREAD TOOLS.—1.

It is not an easy thing for a toolmaker to cut a perfect thread or one even closely approximating perfection in its measurements, especially if it be of the United States standard or Whitworth types. It is comparatively easy to shape the cutting edge to an accurate 60 degrees or 55 degrees, depending on whether the American or English form is desired, but the shaping of the point of the tool to accurate dimensions is a matter of some difficulty. The accompanying sketch will show how this is accomplished by one tool maker who is engaged in the manufacture of thread gages, master taps, etc., and who consequently has much of this work to do.

The blank for the tool is made of rectangular shape with a point formed to the proper angle and the rear end carefully squared. In making the proper flat at the point to cut a United States standard thread it is practically impossible to get dimension C without special instruments. Suppose however that, the sides having been carefully shaped, the distance X from the point of the tool to the rear end is measured with the micrometer. If now the dimension B is known, the point of the tool may be ground off to a distance from the point

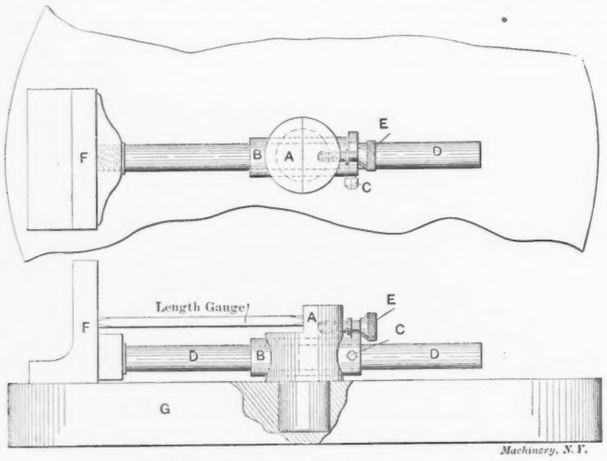


equal to $X - B$ or Y, and if B has been properly calculated we may be sure without measuring it directly that the flat C has the proper width. The dimensions B and C for all usual pitches from 3 per inch up to 100 per inch are given in the data sheet sent with this issue of MACHINERY, and are tabulated there in convenient form for use. Dimensions are also given for the V-thread, the Whitworth, and the Briggs standard pipe thread.

ITEMS OF MECHANICAL INTEREST.

WORK SETTING TOOL FOR LATHE AND BORING MILLS.

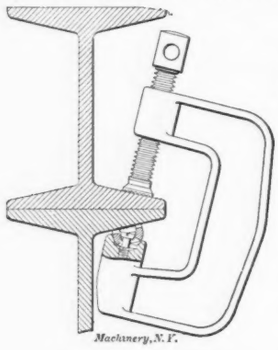
A writer in the *Mechanical World* describes a convenient work-setting tool for lathes and boring mills, particularly the latter. The cuts show the device and its use in setting up the angle plate, *F*, and the same method of use applies when chucking a piece of work off center. The central pin, *A*, which fits the center of the table is bored at right angles to receive the sleeve, *B*. This sleeve is provided with a setscrew, *C*, and a lug on the upper side for the milled head adjusting screw,



Work Setting Tool for Lathe and Boring Mill.

E. The rod *D* is fitted in *B* and one side is flattened for the setscrew, *C*. In use the adjustment is first obtained by sliding the rod *D* to its approximate location, where it is locked by the setscrew, the final adjustment being gotten by the adjusting screw, *E*. The lower sketch also shows how a length gage may be used in connection with the device, a shoulder being provided on the upper end of *A* whose face passes through the center of the table. It is, of course, necessary that the shank of the device fit the boring table hole closely.

SCREW CLAMP WITH SPHERICAL ADJUSTMENT.



An Adaptable Clamp.

Robert Grimshaw sends a sketch of a clamp designed for holding objects, like the flanges of I-beams, that do not present parallel surfaces. It is made of a steel casting and has an I cross section with stiffened back, and if sprung can be brought back to proper shape when hot, like forged ones. The spherical bearing on the under jaw allows all the adjustment out of parallel that is ever likely to be called for.

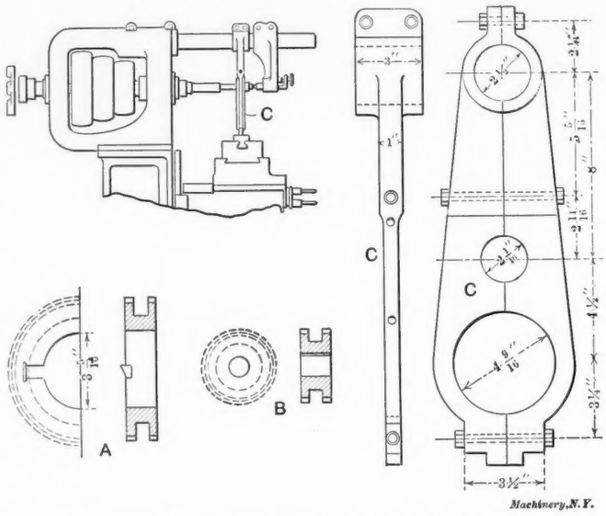
WHAT IS ELECTRICITY?

In the course of a phonographic address which was "machine delivered" before the Electric Club of Cleveland, December 15, Mr. Charles F. Brush said: "The old, old question, 'What is electricity?' is more to the front than ever before, but we need no longer make the old, unqualified and humiliating answer, 'We do not know.' We are now fairly on the way to finding out. The brilliant researches and speculations of J. J. Thompson and others seem pregnant with knowledge. We are told that the flying particles, or ether corpuscles, of the Crookes tube are far smaller than the chemical atom; that their mass is little more than the thousandth part of that of the hydrogen atom; that they move with a velocity of the order of the velocity of light, and that each corpuscle carries a definite and invariable charge of negative electricity.

"Inasmuch as the corpuscle always carries the same charge, whatever gas is the source of the corpuscle, some physicists hold that the corpuscle consists wholly of electricity. If this view is correct, then electricity, or at least negative electricity, must be regarded as a form of matter, and not a phenomenon of the ether, as hitherto supposed, because the corpuscle is certainly endowed with the properties of mass and inertia, the most fundamental attributes of matter. The same physicists advance the hypothesis that all forms of matter are composed wholly of electrical corpuscles, grouped in various ways, to form the chemical atom. This is an exceedingly interesting speculation, but cannot be verified or refuted until we know far more than we do now about positive electricity, and how it is associated with the negative corpuscle to form a neutral combination."

TOOL FOR TURNING WRIST PINS AND TUMBLING SHAFTS

An interesting special tool for turning wrist-pins, tumbling shafts, etc., was described in a recent issue of the *Railway Master Mechanic*. This tool is the design of Mr. John Tonge, master mechanic and master car builder of the Minneapolis & St. Paul Railroad at Minneapolis, Minn. It is used on the milling machine or lathe according to the class of work. The wrist-pins of four bar guide crossheads are turned on the milling machine with this device, as shown in the accompanying cut. Of course on a job like a crosshead or any other job having shoulders which prevent sufficient over-travel of the tool, the tool must be set twice in order to finish the surface. The device consists of a frame, *C*, split on its center line in two parts, which are solidly secured as one when in



Attachment to the Milling Machine for Turning Wrist Pins.

operation, by bolts at the center and ends. The smaller end of the frame is secured to the arm of the milling machine, and the center hole is brought in line with the machine arbor which passes through it, and the pinion, *B*, is splined to the arbor. This pinion meshes into a gear, *A*, which is made in halves and fits the larger hole in the frame. Both of these gears are grooved to fit the frame in which they work and cannot therefore leave their respective positions. The larger gear has an internal diameter large enough to clear the largest wrist-pin, and is fitted with a cutter by which the turning is done. The motion imparted to the pinion by the arbor is communicated to the gear which in turn drives the tool. When used on the lathe for turning tumbling shaft bearings a gear is screwed on the spindle in place of the faceplate and this meshes in a pinion mounted on a short splined shaft which drives the pinion *B* in the same manner as the spindle of the milling machine.

* * *

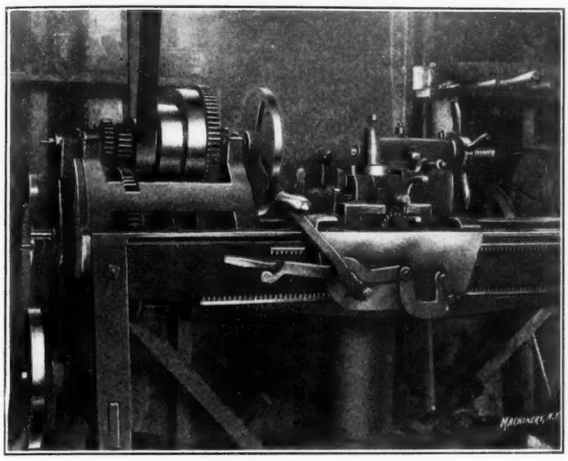
In a contributed article in the last number of MACHINERY upon "A Novel Blueprinting Apparatus" a statement was made to the effect that some of the more elaborate electric blueprinting machines were sold at a price of $500 each. While this statement is correct it is also true that machines, complete in every detail, can be had for less. J. H. Wagonhorst & Co. write us in regard to this calling attention to their electric blueprinter which although a complete and satisfactory machine, is sold for less than one-third this price. We are glad to mention this as of interest in connection with the above referred-to article.

LETTERS UPON PRACTICAL SUBJECTS.

AN ANCIENT ENGINE LATHE.

Editor MACHINERY:

Hunting with a camera will at times result in securing interesting and peculiar specimens. The machine shown in the accompanying photograph is at first sight a crude affair, but upon closer investigation will be found to have all the feeds and adjustments of any ordinary engine lathe. It is located in a country village job shop and is a strictly home-made affair. The man running it said that he wanted no better, a remark that might be loaded both ways. The bed consists of two cast-iron beams held the required distance apart by cross bars, and the whole drawn together by bolts.



An Ancient Engine Lathe.

It is supported upon wooden legs and carries two racks upon its front. The feed gear in the apron can be made to mesh with either rack, as desired, for reversing the direction of carriage travel. The feed rod is inside the bed and connects by means of a gear train with the apron gearing. One gear of the train is visible below the cross-feed handle and by substituting a gear for the cross-feed handle a power cross feed is obtained. The back gears are placed beneath the cone, weakening the headstock frame considerably. The footstock spindle bearing is adjustable on the cricket for taper turning and a leadscrew is provided at the rear. The machine is thus a screw-cutting engine lathe of novel design and is a complete tool.

H. P. FAIRFIELD.

Worcester, Mass.

THE GEARED DRIVE.

Editor MACHINERY:

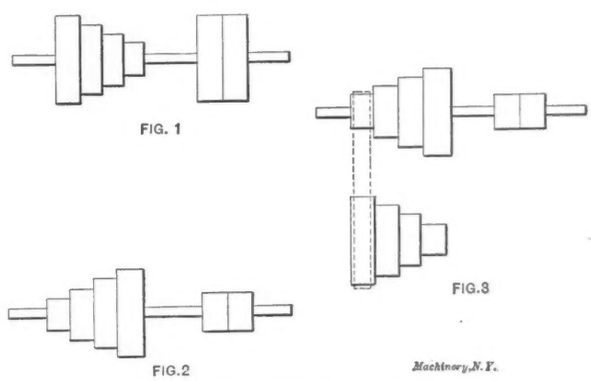
The article by J. C. Steen recently published in MACHINERY (December, 1905) points out the radical difference between stepped or cone pulley drive and single pulley, or geared drive, in favor of the former. It states clearly that the substitution of the cone pulley is not due to any inherent defect in the cone pulley itself. As this subject is, no doubt, of interest to many at the present time, I would make some exceptions.

It is a common sight in the shop to see a machine, cone pulley driven, doing its heaviest work up to the capacity of the machine, with the belt on one of the middle steps of the cone. This is a compromise on the part of the machinist. He has tried and found out that with the belt on the largest step of the cone he could not get enough power for a substantial cut, and he knows that the belt on the other end of the cone would be out of the question. As a matter of fact, these tools have been designed for doing the heaviest work at its maximum capacity, with the belt on the largest step of the cone, but they do not do it for two reasons: First, the largest step of the machine-cone delivers the minimum of power, equal to the amount delivered by the smallest step of the counter cone at the countershaft velocity. Secondly, notwithstanding the fact that, according to figures, the largest step of a machine cone should give the maximum pressure on the tool, or maximum torque, it does not generally do this because the smallest diameter of the counter cone is as a rule too small for the belt, with very few exceptions, and as a result of this small diameter the belt slips.

A countershaft as shown on Fig. 1 is familiar to all of us. The width of belt from the line shaft is generally the same or slightly heavier than that on the cone, and the diameter of the tight and loose pulleys is generally equal to the maximum diameter of the cone. This is another compromise on the part of the designer which does not agree with what the machine has to do. We naturally expect that a 10-inch shaft will stand a heavier cut than a 2-inch shaft, and the same could be said in reference to all kinds of work, consequently a machine should be provided with power enough to take the heaviest cut, at the limit of cutting speed, and at its full capacity. This maximum power is delivered to the machine from the smallest step of the counter-cone, measured at the countershaft speed in R. P. M. The same amount of power is delivered to the countershaft through a tight and loose pulley, measured also at the counter speed, with a slight surplus to cover friction loss in the countershaft. In consequence of this, the diameter of the tight and loose pulleys should be practically the same as the smallest diameter of the cone, and a countershaft would appear as shown in Fig. 2, but nobody would stand for such a thing, so much has "looks" to do with things mechanical.

Another consideration worth mention is the belt speed for efficiency. With reference to Fig. 3, showing counter and machine-cone connected, if the belt in the position shown (which is the most important) is speeded up satisfactorily, when placed on the other extremes of the cones it would run too fast, and, furthermore, the peripheral speed of the machine-cone in this condition might be out of the question in many instances.

If we were to consider a two-speed countershaft drive, which is sometimes necessary with the cone type drive, the difference that we have just seen would be still greater, and all the odds seem to be against the cone pulley.



The Cone Pulley Drive for Machine Tools.

These faults appear to be inherent with the cone pulley drive and come out more prominently as the range of the speeds is increased, and more so, as the output of machine tools approaches its limit.

A. M. SOSA.

Hamilton, Ohio.

MAKING BLUEPRINTS FROM TYPEWRITTEN ORIGINALS.

Editor MACHINERY:

The article in the January issue by W. H. A. on making blueprints from typewritten originals suggests to my mind the thought that perhaps the idea of printing from the carbon sheet itself is not generally known. We regularly use bond paper for making out material lists for shop use, using black "non-smut" carbon paper, reversed to print on the back side of the original copy; this in connection with black non-copying

ribbon in the machine will make very good legible copies. But it is sometimes desirable to have prints that can be readily used for notes. To get these the first carbon sheet can be used for the printing as was done in the case of the sample print sent herewith. The brush marks on the carbon paper show up on this sample rather plainer than is often the case, but still the print is legible and pencil marks will show up clearly.

The idea of printing from the carbon sheet is often of value when a customer wants a blueprint and feels slighted if a pencil sketch is sent him. All parties can be satisfied by using fresh carbon sheet in the sketch pad, and using this carbon sheet to print from. These carbon sheets require about the same care in handling as tracing paper, and by using a little care in making clear sharp lines, they will give prints of a pleasing appearance. C. J. M.

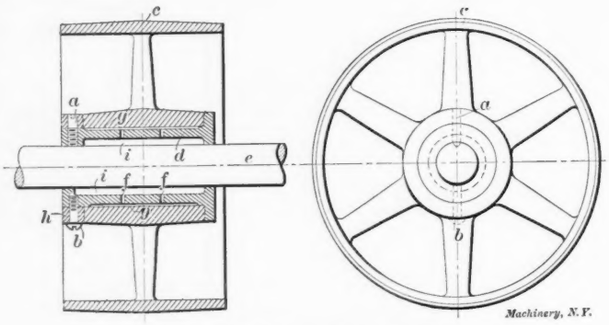
[The sample sent shows blue figures on a tinted ground, which although not white can be legibly written on with pen or pencil.—EDITOR.]

LOOSE PULLEY BEARING.

Editor MACHINERY:

I send you a blueprint showing a special loose pulley bearing which I have been using with good results, and following is a description of same:

A chamfered bushing, *d*, is mounted on the shaft and set tight with a setscrew, *a*, which also holds ring *h* in place. This ring is a collar to hold pulley from side motion. The bushing has a chamber, *i*, which connects with the outside face by small holes, *f*. The outside face is grooved toward the ends from the small holes; the holes are also connected by groove *g*. *b* is a machine screw filling a hole which communicates with chamber, *i*.



Self-lubricating Loose Pulley Bearing.

Pulley *c* runs loose on bushing *d;* the grease lubricates through holes, *f*, and is distributed along surface by means of grooves, *g*. The chamber, *i*, is filled by melting hard grease, which is poured into the chamber by removing the screw, *b*. When the bearing receives insufficient lubricant it becomes warm and more will be supplied through the openings, *f*, the grease becoming soft. I have had several of these pulley bearings running for a month at a time without refilling, and the surfaces were like glass when examined.

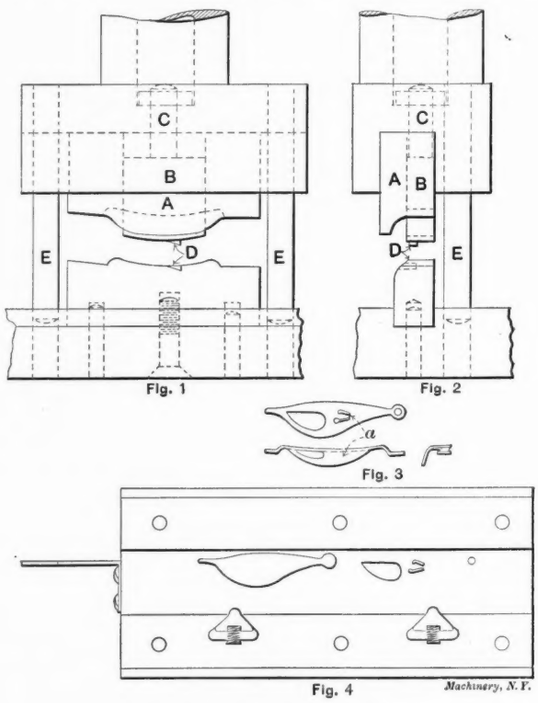
Milwaukee, Wis. C. P. BOSSERT.

DIES FOR MAKING SHUTTLE SPRINGS.

Editor MACHINERY:

The cuts, Figs. 1 and 2, show a set of dies which I made a short time ago for manufacturing the shuttle spring shown in Fig. 3. The blanking die, Fig. 4, is of the familiar "gang" or "follow" type and needs no description. The forming die, however, contains some new points in this class of tools. At least they are new to me, and I have made tools for twenty or thirty different shuttles. We had been making our forming punches of one piece of steel and the product didn't seem to come out uniformly shaped. This former, however, overcame the trouble and I learned some valuable points from it.

The forming die is made of one piece of steel worked out to the shape desired. The forming punch is made of a stationary piece, *A*, and a sliding piece, *B*, which operates within a cavity in the piece, *A*, as shown. A plunger, *C*, with a nut screwed onto the upper end works in a cavity in the head and forms a stop for the sliding piece, *B*, to which it is attached. A stiff spring in the punch head cavity is used to keep the nut against the shoulder in the cavity. This spring must be stiff enough to form and hold the shuttle spring firmly against the die while the rest of the bending is being done. This is the point we overlooked in our other formers. The stock draws away from the "sway" in the body of the spring three ways, and in the old dies these three bends were made first and there was no stock left for the "sway" or curve where the tension comes on the thread; consequently no two came alike. Another feature of this die for this particular spring is that it not only forms the spring but also cuts and forms the point marked *a*, Fig. 3.



Dies for Making Shuttle Springs.

We used heavy dowel pins, *E E*, to insure the alignment of this die. They are a good running fit in the die and are driven into the punch head, making them rigid.

When in action, the sliding piece, *B*, is the first to strike the spring blank, which is located on the forming die; it cuts the spring point *a* and forms it, at the same time putting the "sway" in the body of the spring. It holds it securely in this position by means of the spring on top of plunger *C* until the two ends and side are formed as shown. The stock used was spring steel 0.015 inch thick by ¾ inch wide and was run through the blanking die twice, cutting two rows of spring blanks one on each edge of the stock. V. H. MARCELLUS.

Dayton, Ohio.

COST ESTIMATING.

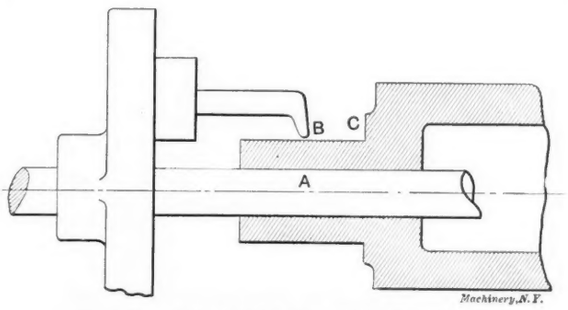
Editor MACHINERY:

Your appeal for data on the subject of cost estimating has not to my knowledge received any reply. This is not surprising. All estimating of which I have any knowledge is more or less intellectual guessing based, in general, upon observed data and perhaps on personal experience. It is mainly intuitive. Though a great amount of data must be available to form many really accurate computations of labor cost it is not the main item. By not the main item I mean not the hardest thing to learn as regards estimating. In your editorial you ask for details of how allowances are made for setting, changing, sharpening tools, etc. This is exactly the part of cost estimation that relies almost solely on intuition. As an instance a boring operation may be cited. The area tooled would be calculated out and costed, allowance made for, say, the small diameter of the boring bar allowable; when it comes to allow for setting, the time is almost always esti-

mated or guessed, which ever you please, and moreover with a man who knows the business, generally guessed about right.

Mention was made just above of calculating cost from the area of surface tooled. This is a very rational and a much used form of data. For instance, ordinary bedding down and scraping may be allowed for at 60 cents per square foot, the getting up of surface plates at 84 cents per square foot. Obviously this does not cover a great many allowances which have to be made in practice. The cut shows a trunnion for a drilling machine arm, which has to be machined in a boring machine. The boring of hole *A* may be done at ordinary speeds but the speed of machining of the trunnion *B* and the facing of *C* is to some extent limited by the size of the hole *A* which ties the diameter of the boring bar and also by the length of the trunnion which decides the overhang of the tool.

When one has made many estimates the time taken on such operations as setting and squaring up a job on the machine or setting the cams on an automatic machine operation where there can be little data that is of any use—the reasoning followed is somewhat obscure and not easily explainable. When one is new to the business, or the operation a serious one, it may be planned out and every movement allowed for; if not, the operation is mentally summed up and a time suggests itself, without direct thought of details.



Example of a Cut taken under Limiting Conditions.

A matter which would tend to minimize the value of the data, if given, is the variety in the finish of a product. Obviously the time taken is dependent to the greatest extent on the limit of error allowable in the operation and upon the trouble taken to bring the product up to a high grade. Most of the data to be used in any shop must be gathered in that shop and a lot of it is misleading if gathered elsewhere. Naturally the boring of a clearance hole will not cost as much as a small engine cylinder of the same size. But the accuracy and finish of engine cylinders vary enough to make appreciable difference in the cost of production. The accuracy of finish, too, is hard to explain. Everyone sets up his own standard. For instance, I have seen inspectors' report sheets on which the limit of error allowable for certain things were printed as zero. No doubt to the inspector's standard these points were perfect when he passed them, but his standard fortunately is not that of every one. If the machines had to be passed by someone whose perfection standard was higher it is conceivable that the cost would be greater. H. T. M.

TO CLEAN A TRACING.

Editor MACHINERY:

Tracings soon show the results of frequent use by becoming soiled, which while causing them to look bad at the same time makes it impossible to take nice clear blue prints from them. Often times changes and corrections are "penciled in" on a tracing before inking in. This leaves a confusion of penciled lines and figures. All this can be easily removd by lightly rubbing the soiled portions with a cloth which has first been saturated with benzine or gasoline. This while cleaning the tracing thoroughly will not affect the ink and makes the tracing look almost like new.

After making erasures on a tracing I always take a talc pencil, or soapstone as it is some times called, and rub over tracing cloth at place of erasure. This gives the cloth a new surface which will take ink nicely and will not catch the dirt.

Sharon, Pa. R. F. KIEFER.

TWO USEFUL FORMULAS.

Editor MACHINERY:

I give below a couple of rules which I have found useful. The first is for finding the weight per running foot of pipes, tubes and columns, and is expressed in the following formula:

$$W = K\ (D^2 - d^2)$$

in which

D = outside diameter.
d = inside diameter.
W = weight per running foot.
K for wrought iron = 2.64
K for cast iron = 2.45
K for brass = 2.82
K for copper = 3.03
K for lead = 3.86

The constant for cast iron (2.45) is based on cast iron weighing 0.26 pounds per cubic inch, or 450 pounds per cubic foot, it is best to add 10 per cent to these figures in order to provide for overweight in the foundry.

The second rule or formula is to find the number of teeth in a pair of gears in which the distance between centers, ratio and pitch are given:

$$N = \frac{C\,2\,R\,P}{R + R_1}$$

$$n = \frac{C\,2\,R_1\,P}{R + R_1}$$

in which

C = center to center of gears.
R and R_1 = terms of the ratio (substitute highest term for R.)
P = diametral pitch.
N = number of teeth in large gear.
n = number of teeth in small gear. ALEX. C. LABAR.

Chattanooga, Tenn.

A SELF-CENTERING CENTER PUNCH.

Editor MACHINERY:

Under the above title in the December issue of MACHINERY is found described and illustrated a neat and handy tool for the purpose intended, but I fail to appreciate the necessity of making such an elaborate affair and wish to submit the following as a substitute. Although there is nothing new or novel about it, I believe it has some superior features.

Fig. 1 shows two forms of the style of punch to use for the purpose referred to in the article mentioned, *i. e.*, transferring the centers of a number of holes already drilled onto the surface of another plate or flange.

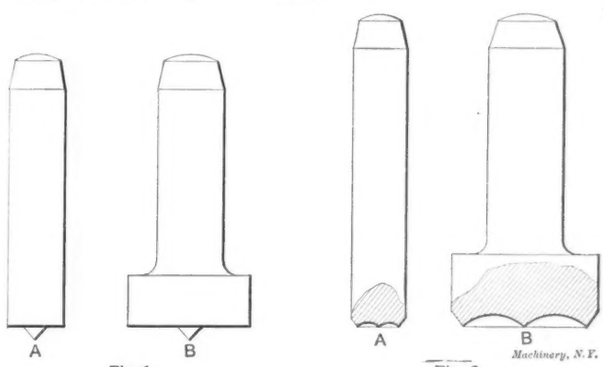


Fig. 1. Fig. 2.

Two Forms of Self-centering Center Punches.

Form A is suitable for the smaller sizes. Form B should be used where the holes through which the punch is to be used are so large as to make the mass of a straight punch objectionable. Fig. 2 shows a style of punch suitable to mark through free holes for tap drilling on the corresponding plate or flange where cap screws are to be used to fasten the two pieces together. The impression from these punches furnishes an outer line or circle to drill to.

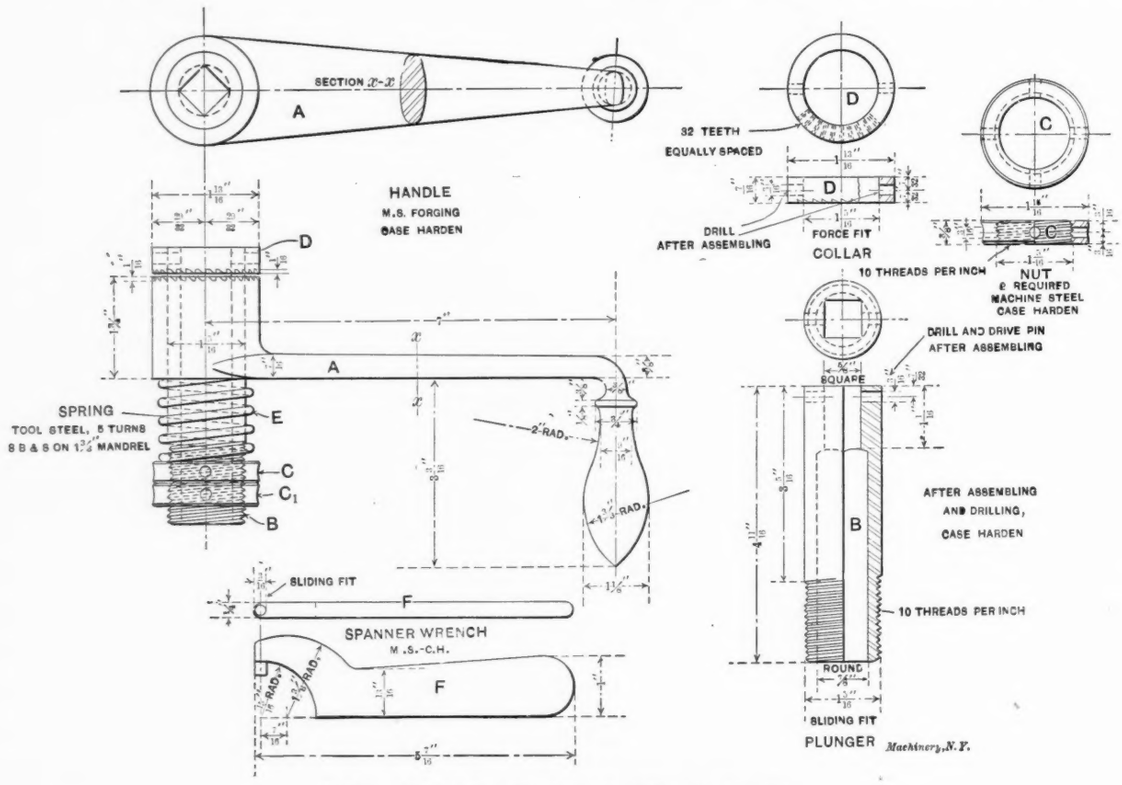
The advantages of these punches over the one referred to in the previous article are that the labor upon the complete punch is no more than upon any one piece of the other;

there are no moving parts to become stuck by dirt or grit, and no spring to bother or break. I will suggest another method for this class of work which, if practical, will do away with any punching whatever. That is, clamp the piece first drilled upon the surface to which it is to be bolted and if the holes in the second piece are to be of the same size as those in the first piece, simply drill through the first piece into the second, using the pieces first drilled as a guide. If however, the holes in the second piece are to be tapped, "spot drill" through the first piece into the second, use a drill of the same size as that used for the first piece but feed it through the first piece into the second only the depth of its full cutting edge, then remove this drill from the socket and replace it with one of required diameter for tapping. Enter it into the "spots" made by the larger drill and drill through or to the required depth. CLAY-BEAN.

RATCHET STOP HANDLE FOR MILLING MACHINE VISES.

Editor MACHINERY:

The drawings reproduced herewith show a ratchet stop handle for milling machine vises, and its parts. The object sought in this handle is the avoidance of springing the pieces to be milled and the securing of a uniform pressure on each piece when many are to be milled.



Details of Ratchet Stop Handle for the Milling Machine Vise.

The construction is plainly shown in the cut and little description is necessary. A plunger (so-called) *B* is threaded on one end to receive the nuts *C* for regulating the pressure of the spring *E*. The plunger is broached out at one end to fit the square on the milling machine vise screw and is free to slide within the handle *A*. The collar *D* is pinned fast to *B*, and one side is milled with ratchet teeth corresponding to those milled on the face of the handle bars. In use, when the desired degree of pressure has been developed on the screw, the teeth slide past each other, thus preventing over-pressure. Turning the handle in the opposite direction loosens the vise screw, the teeth then acting positively. The teeth may be cut at an angle of 30 degrees, or less.

Newark, N. J. HENRY F. HOWARD.

[The idea embodied in this handle is one that can be profitably used on other tools where repetition work is being done by comparatively raw labor. Nothing is more common than to see the screws of vises and other clamping devices in a badly worn and strained condition simply because of overpressure caused by careless operators. We would suggest that in the device illustrated the matter of spring adjustment be taken entirely out of the hands of the operator and that the adjusting nut *C* be pinned to the plunger *B* rather than secured by a lock nut. The average operator would no sooner find out that the handle slips after a certain pressure is applied than he would set up the nuts sufficiently to make a practically solid handle, if not restrained.—EDITOR.]

RULES FOR FINDING THE CAPACITY OF STEAM HAMMERS, AND THE HORSE POWER REQUIRED FOR OPERATION.

Editor MACHINERY:

I beg to call your attention to some simple rules regarding steam hammer practice, which may be of value to some of your readers. The first of these rules gives the horse power required to run a hammer of any size and may be expressed as follows:

Divide the rated capacity of the hammer, in pounds, by 100, *and the quotient will be the horse power required to run the hammer constantly.*

This rule is also applicable in cases where the hammer is not run constantly, by estimating the amount of time the hammer is idle each hour and making allowance therefor. But it will be noted that in case the hammer is not run constantly, or nearly so, and the horse power is correspondingly reduced, sufficient steam storage space must be provided in the boiler to prevent the steam pressure being drawn down much faster than it is made during the working period.

The second rule deals with the estimate of the proper size of hammer to be used in working iron and steel of any desired cross-sectional area. The rule is as follows:

Multiply the greatest cross section desired to be worked in the hammer by 80, *if of steel, or* 60, *if of iron, and the product will be rated value of the hammer required in pounds.*

This rule will give a hammer for safely working material of the size specified, at one heat. No doubt many of the readers are doing what we frequently do, that is, work billets which exceed in size that which would be allowable if the rule was always followed. But, in general, it will be found that

it gives what will probably prove to be the most economical practice in working steel and iron under a steam hammer. To make these rules clear I append an example: What size hammer will it require to work a 4 by 4 inch square steel billet, and how much horse power will it require?

Solution: $4 \times 4 = 16$; $16 \times 80 = 1{,}280$. Size of hammer required 1,280 pounds. $1{,}280 \div 100 = 12.8$, or boiler horse power required.

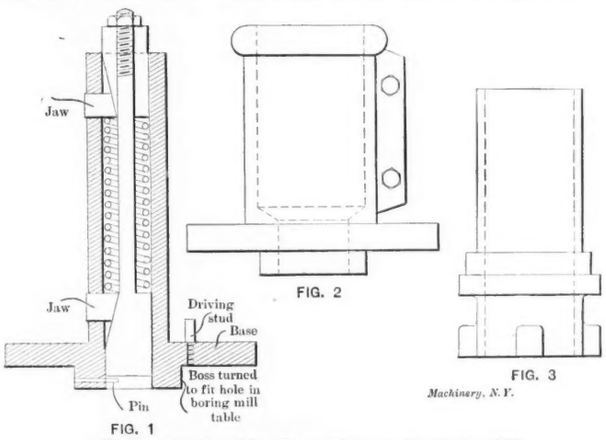
In any event these rules will be found perfectly safe to follow in making up estimates and they are used by at least one of the largest steam hammer builders in this country.

Richmond, Va. L. N. GILLIS.

BORING MILL FIXTURES FOR TURNING AND BORING STEAM PUMP LINERS.

Editor MACHINERY:

Figs. 1 and 2 of the accompanying cuts represent fixtures used on a boring mill for turning and boring liners for steam pumps, and Fig. 3 is the liner. Contrary to the usual custom the liner is first turned and after bored. Fig. 1 is the chuck on which the liner is turned; the body of the chuck is made of cast iron. The boss on the bottom is turned to fit the hole in the boring mill table and the base is slotted to receive clamping bolts. The jaws are six in number, three at the top, and three at the bottom, and are forced out by the two sliding blocks in the bore of the fixture, being drawn together by the nut at the top. Each of these sliding blocks has three equally spaced slots cut in them, at a taper of 3 inches to the



Fixtures for Chucking Pump Liners in the Boring Mill.

foot, which move the jaws out. The coil spring forces the blocks apart upon the tightening nut being unscrewed, and releases the work. A pin is driven in the bottom of the bore, to act as a stop for the bottom block. The work is driven by a stud shown in the base.

After the liner is turned the fixture shown in Fig. 2 replaces that shown in Fig. 1. This fixture is bored and split to fit the turned portion of the liner, which is tightened in place by the two clamping bolts, and is then bored and reamed.

C. P. L.

RECEIPT FOR MAKING A FIRST-CLASS MACHINIST.

Editor MACHINERY:

First, take a liberal amount of conceptive brains, possessed by an intelligent boy of 18 years of age; second, add to these six months experience in a large jobbing machine shop as "roustabout"; third, add one-and-a-half years experience on machine operation; fourth, with a club, crowbar, or sledge hammer, knock all of the conceit out of the boy; fifth, add one-and-a-half years experience in erecting work; sixth, add to this combination four parts of good horse sense, three parts of confidence, four parts of executive ability, three parts of endurance, one part nerve, one part attentiveness; seventh; stir these ingredients together well, in large bowl of sobriety with a club known as a year's experience at "roughing it"; eighth, smooth down with some fine emery cloth, and serve immediately.

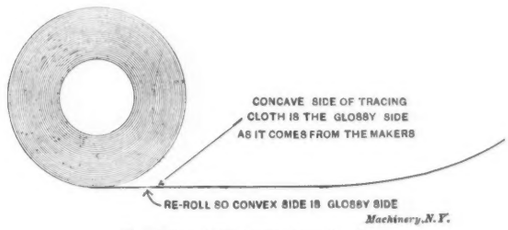
I will guarantee that in nine cases out of every ten this receipt will produce a first-class all-around machinist.

Pearl River, N. Y. H. E. WOOD.

RE-ROLLING TRACING CLOTH TO PREVENT CURLING.

Editor MACHINERY:

Probably all, or nearly all, draftsmen are troubled with tracings curling up at the edges when filed away in drawers. It seems almost impossible to make them lie flat and when put into the printing frame the edges get folded down and make bad looking edges on the prints. Not very many draftsmen like to use the dull side of the tracing cloth, though drawings made on this side will keep flat much better than when the glazed side is used. Some time ago I came to the


CONCAVE SIDE OF TRACING CLOTH IS THE GLOSSY SIDE AS IT COMES FROM THE MAKERS
RE-ROLL SO CONVEX SIDE IS GLOSSY SIDE
Machinery, N.Y.

To Prevent Tracings from Curling.

conclusion that this was due to the fact that when manufactured the cloth is rolled with the concave side the glossy side as shown in cut, which of course causes it to curl. With a view to overcoming this I took a roll of tracing cloth and rerolled it, putting the dull side in. This roll I left lying away for a month or more before using it and found that there was a great improvement and that the drawings made on glossy side were curled down at the edges rather than up. If one should make some sort of a rewinding device for the purpose I think it would be found to be worth the trouble.

W. E. M.

CHANGING GEAR RATIOS.

Editor MACHINERY:

In the October issue of MACHINERY Mr. Josselyn explains a method of changing gear ratios when the number of teeth and the center distance are fixed. While I do not wish to criticise his method, I would like to suggest another, and what I think a more simple way of doing it. Taking Mr. Josselyn's first example, assume a driving shaft running 100 R. P. M., and that it is desired to revolve the driven shaft 60 R. P. M.; the total number of teeth to be utilized is 120. $60/100 = 3/5$, as 60 is to 100, so 3 is to 5. We have 120 teeth to be divided in the proportion of 3 to 5. $5 + 3 = 8$; $120 \div 8 = 15$. Multiplying both numerator and denominator of 3/5 by 15 we have 45/75, 45 being the driver.

Taking the second example, assume a driving shaft running with 100 R. P. M. and that it is desired to run the driven shaft 150 R. P. M. Total number of teeth to be utilized is 120. $100/150 = 2/3$. $2 + 3 = 5$; $120 \div 5 = 24$. Multiplying both numerator and denominator of 2/3 by 24 we have 48/72.

We readily understand that the large gear should go on the shaft which we want to run the slowest in each case.

Cleveland, Ohio. C. M. MCELHANY.

* * *

The first concrete skyscraper is the Ingalls Building, of Cincinnati, Ohio. It is sixteen stories, rising to a height of 210 feet from the sidewalk. It should be noted that this building differs from the usual form of skyscraper, having a steel frame and brick or granite skin, with the skin entirely supported by the steel frame. The Ingalls Building is a concrete box, as it were, having eight-inch walls of reinforced concrete, being entirely devoid of the usual I-beams, Z-bars, angle-irons, etc., characteristic of the steel frame skyscraper. The Ransome system of reinforcement, consisting of cold-twisted square bars is used throughout. The fact that buildings sixteen stories high can be successfully constructed of concrete seems to answer any questions as to whether concrete is a practicable building material. It would seem, in view of the scarcity of lumber and its rapidly-increasing price, that concrete ere long must be an almost universal material for building construction as well as engineering operations generally where masonry or steel have had the call in the past.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO TREAT FOREIGN MATTER IN THE EYE.

At night when you get home and find you have a piece of iron or other foreign matter in the eye that irritates it, and you have no way of removing it until morning, take a raw Irish potato, grate it, and use as a poultice on the eye; it will ease the eye so you can sleep, and if it does not draw the piece out, you can have it removed next morning as the eye will not be inflamed, unless it is a very bad piece. I have used this frequently, and it is the best thing I have ever tried. C. P. L.

TO PREPARE EMERY FOR LAPPING GAGES.

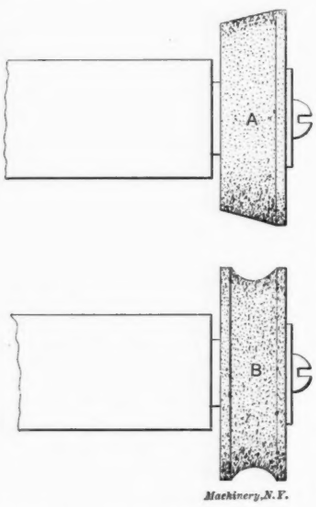
To prepare emery for lapping screw gages, plugs, etc., fill a half-pint bottle with machine oil and flour emery in the proportions of about 7 parts of oil to 1 part of emery by bulk. Mix thoroughly and let stand for twenty minutes during which time the heavier particles of emery will settle to the bottom. Now take the bottle and carefully pour off about one-half the contents without disturbing the settlings. The portion poured off contains only the finest emery and will never scratch the work.

For surface lapping put some flour emery in a linen bag and tie up closely with a string. Dust out the emery by striking the bag against the surface plate; use turpentine for rough lapping and the dry surface plate for finishing.

New Haven, Conn. A. L. MONRAD.

DRESSING GRINDING WHEELS TO PREVENT GLAZING.

In circular grinding, the wheel is often beveled as at *A* in order to present less grinding surface to the work. This lessens the tendency to glaze, and in internal grinding allows the wheel to pass through the piece being ground with only a small clearance between the work and the chuck.



Machinery, N.Y.

However, where there is room for the whole wheel to over-travel the work, the wheel should be dressed as at *B*. Not only does this form prevent glazing, as the form *A*, but it has the advantage of two cutting edges, and the wheel wears less rapidly.

O. L. LEWIS.

Indianapolis, Ind.

[As an expedient this practice may be good, but it is better to select a grade and width of wheel that can be used with the full surface working, both on the score of economy of wheel material and time saved in dressing.—EDITOR.]

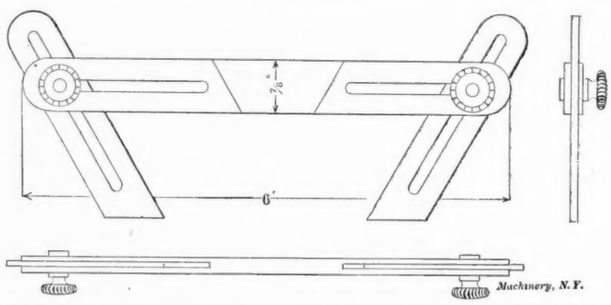
TO CASEHARDEN LOCALLY.

In casehardening certain articles it is sometimes necessary, or desirable, to leave spots or sections in the original soft uncarbonized condition while the remainder is carbonized and hardened. This may be effected by first covering the parts to be hardened with a protecting coat of japan, and allowing it to dry. Then put the piece in an electroplating bath and deposit a heavy coat of nickel over the parts not protected by the japan. The piece thus prepared may be treated in the usual manner in casehardening. The coat of nickel prevents the metal beneath being carbonized so, of course, it does not harden when dipped in the bath. BRISTOL.

[A plating of copper answers the same purpose as nickel and is often used. A simpler plan, where the shape of the piece permits, is to protect it from the action of the carbonizing material with an iron pipe or plate closely fitted or luted with clay. Another scheme is to machine the parts wanted soft after carbonizing but before hardening, of course. By this procedure the carbonized material is removed where the metal is desired soft and when heated and dipped these parts do not harden.—EDITOR.]

A DOUBLE-ENDED BEVEL.

The sketch here shown is a very common-looking tool, but I find it a very useful one. It was especially made for getting the bevel on dovetails for pole piece dies, and I have also used it for several other purposes; when you get one you will wonder how you ever got on without it. It is made of sheet steel 0.070 inch thick, which has been cleaned up on a surface grinder. It is very simple in construction, consisting of two

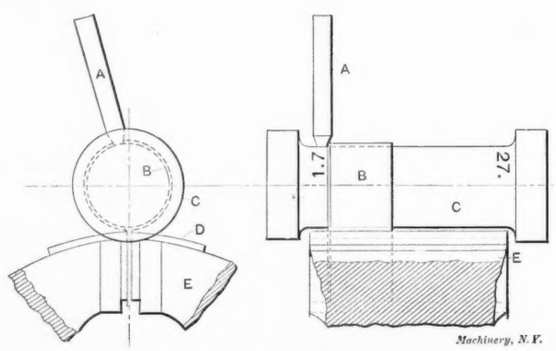


Machinery, N.Y.

flat pieces the full length and one center piece, the shape shown by the dotted lines. When finished it is about 3-16 inch thick, which just gives a nice surface to keep it level on the work. It saves the trouble of making a gage, as it can be set exact and then the work can be shaped out right down to size. The screws are made with a tongue underneath the head, by filing two flats, to prevent turning when being tightened. Any one who goes to the trouble of making one of these bevels will be well repaid. BARNEY.

USE OF A TEMPLET FOR STAMPING WITH STEEL LETTERS.

Having had considerable stamping to do recently with steel letters it was up to me to find a way to do it neatly and get all the letters in line. I found out after some experience that if I made a templet of a thin metal such as tin or sheet brass and clamped it to the work, it was an easy matter to do a good job by setting the letters to the templet. The accompanying sketch illustrates the method of using the templet on a cylindrical piece, say, a standard gage, *C*. The templet



Machinery, N.Y.

is clamped around the body and held for convenience in the jaws of the vise, *E*. The working edge of the templet is beveled to approximately the same angle as the tapered part of the steel letter *A*. Not all steel letters are square with the body but the use of the templet largely rectifies this defect for the reason that the tapered part is usually made square with the face of the letter. FOSTER HILLIX.

Purdue University, Lafayette, Ind.

* * *

Don't file out a hole and attempt to put a shaft in it without making sure that no broken file beards are left sticking inside of the hole.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

149. LUBRICANT FOR LATHE CENTERS.

An excellent lubricant for lathe centers is made by using 1 part graphite and 4 parts tallow thoroughly mixed.

Rock Falls, Ill. E. C. NOBLE.

150. SOLDERING SOLUTION FOR STEEL THAT WILL NOT RUST THE WORK.

A soldering solution for steel that will not rust or blacken the work is made of 6 ounces alcohol, 2 ounces glycerine and 1 ounce oxide of zinc. A. L. MONRAD.

New Haven, Conn.

151. TO BRASS SMALL ARTICLES.

To brass small articles of iron or steel drop them into a quart of water and ½ ounce each of sulphate of copper and protochloride of tin. Stir the articles in this solution until desired color is obtained. R. M.

152. CEMENT FOR STEAM AND WATER PIPES.

A good cement for joints on steam or water pipes is made as follows: 10 pounds fine yellow ochre; 4 pounds ground litharge; 4 pounds paris white (whiting), and ½ pound of hemp cut up fine. Mix together thoroughly with linseed oil to about the consistency of putty. R. M.

153. TO REMOVE HARD GREASE, PAINT, ETC., FROM MACHINERY.

To remove grease, paint, etc., from machinery add half a pound of caustic soda to two gallons of water and boil the parts to be cleaned in the fluid. It is possible to use it several times before its strength is exhausted. F. PAVLIK, JR.

Winnetka, Ill.

154. ALLOY FOR PATTERN LETTERS AND FIGURES.

A good alloy for casting pattern letters and figures and similar small parts in brass, iron or plaster molds is made of lead, 80 parts, and antimony, 20 parts. A better alloy will be lead, 70 parts; antimony and bismuth, each 15 parts. To insure perfect work the molds should be quite hot by placing them over a Bunsen burner. The writer has had thousands of pattern letters and figures made in this manner.

Neponset, Mass. OSCAR E. PERRIGO.

155. COPPER COATING SOLUTION.

A copper coating solution for use when laying out work on iron or steel which I have found more satisfactory than the ordinary blue vitriol is a mixture of saturated solution of zinc chloride with a very little copper sulphate added, say a half-dozen drops of copper sulphate to a spoonful of zinc chloride solution. When a piece of steel is rubbed with waste moistened in this solution it produces a bright copper surface that does not easily rub off. MILTON BURGESS.

Cleveland, Ohio.

156. TO CLARIFY SHELLAC VARNISH.

Even with the best of care the pattern maker will find his shellac leaving dirty streaks on the pattern from various impurities held in suspension in the varnish. These may be entirely precipitated by the gradual addition of some crystals of oxalic acid, stirring the varnish to aid their solution, and then setting it aside over night to permit the impurities to settle. No more acid should be used than is really necessary.

Neponset, Mass. OSCAR E. PERRIGO.

157. CLAYING MIXTURE FOR FORGES.

Running as we do about twenty-four fires in our smith shop, we have experienced some little difficulty in securing a satisfactory claying mixture with which to clay the forges. This difficulty arises, in part, from the fact that the forges are used by inexperienced individuals. After repeated trials with various mixtures recommended, we experimented until we finally hit upon the eminently satisfactory one given in the following: 20 parts, fire clay; 20 parts, cast iron turnings; 1 part, common salt;. ½ part, sal ammoniac; all by measure.

The materials should be thoroughly mixed dry and then wet down to the consistency of common mortar, constantly stirring the mass as the wetting proceeds. A rough mold shaped to fit the tuyere opening, a trowel and a few minutes' time are all that are needed to complete the successful claying of the forge. This mixture dries hard and when glazed by the fire will outlast anything ever tried.

St. Louis, Mo. STANLEY H. MOORE.

158. ETCHING FLUID FOR STEEL.

The following receipt for etching fluid for steel, was highly recommended to me, and I have tried it in comparison with another fluid on hardened steel. I found it will make very neat and sharply defined lines, and does the work very quickly:

Nitric acid, 60 parts; water, 120 parts; alcohol, 200 parts, and copper nitrate, 8 parts. Keep in a bottle having glass stopper. To use the fluid, cover the surface to be marked with a thin even coat of wax and mark the lines with a machinist's scriber. Wrap a bit of clean waste around the end of the scriber or a stick, and dipping same in the fluid, apply it to the marked surface. In a few minutes the wax may be scraped off, when fine lines will appear where the scriber marked the wax. The drippings from a lighted wax candle can be used for the coating, and this may be evenly spread with a knife heated in the candle flame. W. S. LEONARD.

Lansing, Mich.

159. PRACTICAL FORMULA FOR SENSITIZING BLUE-PRINT PAPER.

To prepare the blueprint solutions, dissolve 3¾ ounces of ammonia citrate of iron, in 18 ounces of water, and put in a bottle. Then dissolve 2⅝ ounces of red prussiate of potash in 18 ounces of water, and put in another bottle. When ready to prepare the paper, have the sheets piled one on top of the other, coating but one at a time. Darken the room, and light a ruby lamp. Now, mix thoroughly equal parts of both solutions and apply the mixture with a sponge in long parallel sweeps, keeping the application as even as possible. Hang the paper in the dark room to dry and keep it dark until used. Any of the mixture left, from sensitizing the paper, should be thrown away, as it deteriorates rapidly.

Often, in making blueprints by sunlight, the exposure is too long, and when the frame is opened the white lines of the print are faint or obscure. Usually these prints are relegated to the waste basket; but if, after being washed as usual, they are sponged with a weak solution of chloride of iron, their reclamation is almost certain. When the lines reappear, the print should be thoroughly rinsed in clear water.

Often a drawing, from which prints have already been made, requires changing. The blueprints then on hand are worthless, requiring more time to correct than it would take to make a new print. An economical way of using the worthless prints is to cancel the drawing already thereon, sensitize the reverse side, and use the paper again.

Youngstown, Ohio. JULIAN DAY PAGE.

160. WHITE AND RED SOLUTIONS FOR WRITING ON BLUE PRINTS.

After reading your "How and Why" column in the December issue I thought perhaps you might be interested in the way I make a solution for marking white lines on blue prints. I add to a small bottle of water enough washing soda to make a clear white line, then I add enough gum arabic to it to prevent spreading and making ragged lines. To make red lines I dip the pen in red ink and then add a little of the solution by means of the quill. ED. H. REMDE.

Cleveland, O.

* * *

Mr. A. L. De Leeuw, formerly mechanical engineer of the Niles Tool Works and a contributor to MACHINERY has opened an office in Hamilton, Ohio, for consulting practice. The work he undertakes is the planning of new shops and additions; modernizing of shops; the application of motors to machine tools; designing of special machinery; and the making of standard drawings for such concerns as cannot afford to employ capable talent the year round.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

13. C. G. H.—I should like to present the following questions to the readers of MACHINERY:

How much pressure is required to punch a 1-inch hole through a ½-inch steel plate?

Does the pressure vary in direct proportion to the area of the hole and the thickness of the plate

If this is true, should one take the area of the rectangle for a rectangular hole or the area of a circle having a circumference equal to the sum of the sides of the rectangle?

14. H. A. S.—I have run into a rather difficult problem which will best be explained by the following diagram, Fig. 1. There are three cylinders, as shown, two of them 1 inch in diameter and the other one ½ inch in diameter with center distances as given. The problem is to find the diameter and location of a roll which will just touch these three cylinders.

A.—The solution of this problem may be followed by referring to the diagram shown in Fig. 2. This shows the location of the four circles in question together with the additional lines needed to complete the proof. We know from the information given that

$$a\,b = 1.5$$
$$b\,c = 1.125$$
$$a\,c = 1.25$$
$$r_1 = 0.5$$
$$r_2 = 0.25$$

also since the two larger cylinders are of the same size we know that

$$a\,o = b\,o = R + r_1$$

It will thus be seen that triangle $a\,o\,b$ is an isosceles triangle with sides $a\,o$ and $b\,o$ equal; $c\,d$ is drawn perpendicular to $a\,b$.

$$\therefore a\,e = b\,e = 1.5 \div 2 = 0.75.$$

From a well-known formula for oblique angle triangles we have the following expression:

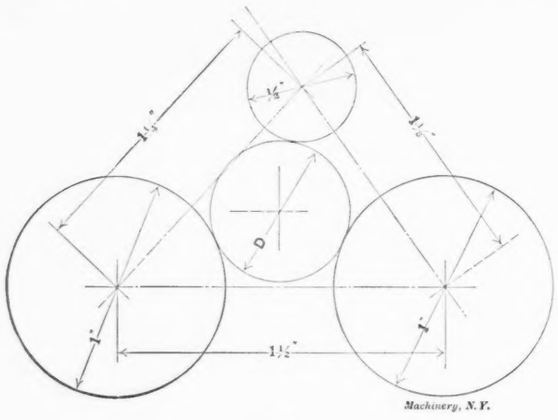


Fig. 1.

$$a\,b : a\,c + b\,c = a\,c - b\,c : a\,d - b\,d. \qquad (1)$$

Since $a\,e = b\,e$, it will be evident that $a\,d - b\,d = 2\,d\,e$. Substituting this value in equation (1) we have

$$a\,b : a\,c + b\,c = a\,c - b\,c : 2\,d\,e$$

solving this for $d\,e$, the unknown quantity, we have

$$d\,e = \frac{(a\,c + b\,c)\ (a\,c - b\,c)}{2\,a\,b}$$

$$\text{and } d\,e = f\,o = 0.09895$$

$f\,o$ being perpendicular to $c\,d$. To find the unknown radius R, we proceed as follows:

$$a\,d = a\,e + d\,e = 0.75 + 0.09895 = 0.84895$$
$$c\,d = \sqrt{a\,c^2 - a\,d^2} = 0.91747$$

Since $a\,e\,o$ is a right angle triangle, we know that

$$e\,o = \sqrt{a\,o^2 - a\,e^2} \qquad (2)$$

$c\,o\,f$ being likewise a right angle triangle we know that

$$c\,f = \sqrt{c\,o^2 - f\,o^2}, \text{ then}$$
$$e\,o = d\,f = c\,d - c\,f = c\,d - \sqrt{c\,o^2 - f\,o^2} \qquad (3)$$
$$\therefore \sqrt{a\,o^2 - a\,e^2} = c\,d - \sqrt{c\,o^2 - f\,o^2} \quad (2 \text{ and } 3)$$

Referring again to the diagram, Fig. 2, it will be seen that $a\,o$ and $c\,o$ are each composed of two parts, one of which is unknown, the unknown quantity being R, the radius of the unknown circle; substituting in this last equation $r_1 + R$ for $a\,o$ and $r_2 + R$ for $c\,o$, we have the following:

$$\sqrt{(r_1 + R)^2 - a\,e^2} = c\,d - \sqrt{(r_2 + R)^2 - f\,o^2}$$

This equation contains but one unknown quantity, R. Solving for this we find that $R = 0.3272$, thus making the diameter of the circle $2 \times 0.3272 = 0.6544$ inch.

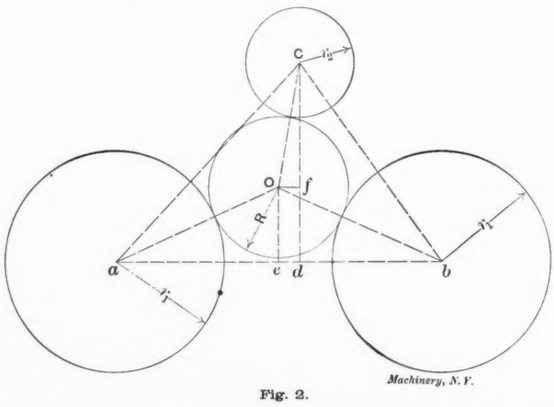


Fig. 2.

Since we can now determine the value of $a\,o$, which equals $r_1 + R$, we can solve equation (2) for $e\,o$. This gives us $e\,o = 0.1276$ inch, and thus locates the center of the tangent circle.

This is a specific case of the general problem which requires the location of a central circle tangent to three known circles of definite location. This particular case is comparatively easy of solution owing to the fact that two of the known circles have the same diameter. The general problem where the known circles are all of different diameters is a puzzler for the draftsman who is unfortunate enough to meet with it. So far as we are aware, no accurate and simple solution has been proposed.

* * *

TO BIND DATA SHEET NO. 48.

Editor MACHINERY:

In questions and answers appearing in the December issue C. E. G. says a number of subscribers would be pleased if you would explain why data sheet No. 48 was made an odd size. Tell C. E. G. to cut off the side, bottom and center margins, leaving the top margin, thus making two equal parts of the sheet; then cut off the top margins for one-half their lengths, leaving the left half in each case. Punch holes in the usual way in this half margin that is left and you have two data sheets that are four times the regular size, which by folding twice, will be the same as the regular size; they can be easily unfolded for reference when bound in book form with the other sheets. H. E. TWOMLEY.

Detroit, Mich.

* * *

Frederick T. Towne, general superintendent of the Yale & Towne Mfg. Co., Stamford, Conn., died on February 4th from Bright's disease. He was born in 1872, graduated from the Massachusetts Institute of Technology and took a course in practical work in the different departments of the Yale & Towne plant. He was made superintendent of the works in 1900 and had been singularly successful in his management, had taken a deep interest in industrial betterment, especially in connection with the Stamford factory, and in educational matters, having organized classes of employees to receive instruction in mechanical subjects. He was a member of the American Society of Mechanical Engineers, president of the Stamford Manufacturers' Association, and had become intimately associated in many ways with the industrial and social life of his home city. Upon the afternoon of his burial most of the local manufacturing establishments were closed as a manifestation of the high regard in which he was held.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

LINCOLN VARIABLE-SPEED MOTOR.

The Lincoln Electric Mfg. Co., Cleveland, Ohio, have designed a line of variable-speed motors especially adapted for direct connection to machine tools. As may be seen from the half-tone, Fig. 1, and the line cut, Fig. 2, the armature may be moved longitudinally by means of the hand wheel at the pulley end of the machine. This hand wheel through the nut *B* operates the lever *E*, which in turn moves the journal and thrust bearings in box *G* in or out according to the direction in which the wheel is turned. To counterbalance the magnetic pull of the field spring *O* is provided.

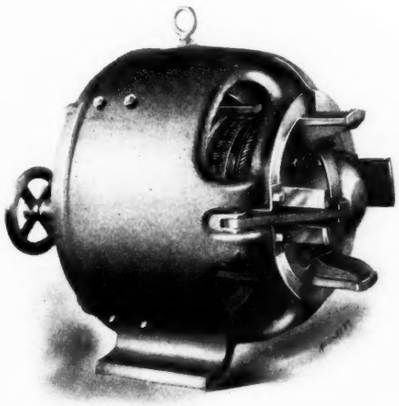


Fig. 1. Lincoln Variable-speed Motor.

When, as is shown in Fig. 1, the armature is drawn to its extreme outward position, it is very largely removed from the influence of the magnetic flux through the poles, thus greatly weakening the field. In accordance with the well-known law governing the action of electric motors, this weakening necessitates an increase in speed of the armature to generate a sufficient counter electro-motive force to balance the current supplied. To more rapidly weaken the strength of the field, the armature is made slightly tapering with the smaller end at the rear so that the air gap is increased as it is withdrawn from beneath the poles, thus still further increasing the resistance of the magnetic circuit and still further increasing the speed of the motor.

To counterbalance the distortion of the magnetic flux a special commutating field is provided within whose influence the armature comes when it is withdrawn for the higher speeds. As may be seen from the half-tone in Fig. 1 this field is in the shape of a horn or projection extending outwardly

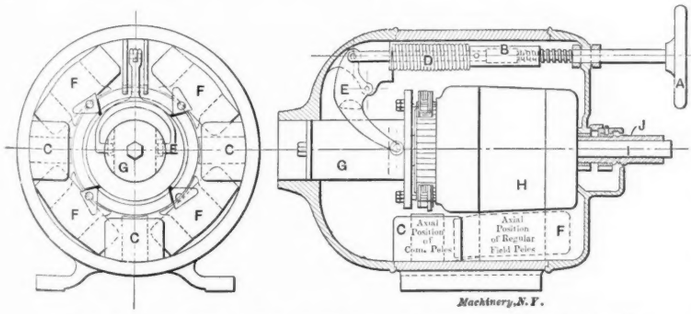


Fig. 2. Section of Lincoln Motor, showing Armature Shifting Mechanism.

from the pole pieces. This extended pole furnishes a field of constant strength at the point where commutation takes place, so that no matter what the distortion of the flux would normally be at the time when a commutator bar is passing under the brush it is working under practically constant conditions. This, of course, is practicable, owing to the fact that the field current is invariable, whatever the speed at which the motor is running. In the design shown in the line drawing, Fig. 2, the commutating pole is arranged somewhat differently. Here supplementary field coils and pole pieces are provided. The current in these coils is constant like that in the main field, the armature being more or less under the influence of these coils as it recedes from or returns to the main magnetic field. A great advantage of this design lies in the fact that the combination of decrease in effective pole area, together with the increase in length of air gap, makes a wide variation of speed possible for a simple motor connected in an ordinary two-wire, single-voltage direct-current circuit. The horse power of the motor is uniform, the torque varying inversely with the number of revolutions per minute at which the armature revolves. The gradations of speed are infinitely small, since the changes are made by a hand wheel and screw which may be placed in any position whatever within the range provided by the machine,

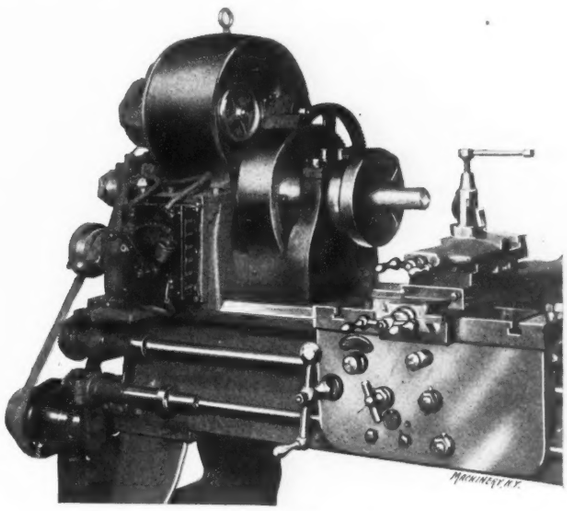


Fig. 3. Lincoln Motor applied to Engine Lathe.

the number of speeds not being dependent on the number of steps provided in the rheostat resistance, as is usual with the ordinary variable-speed motor.

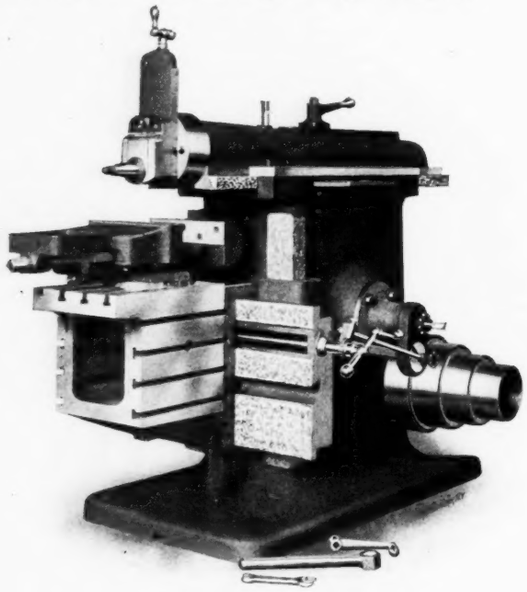
In mechanical construction the machine is designed to meet the highest standards of electrical machinery building. The bearings are self-oiling with reservoirs of ample capacity for supplying the bearings for a long time. The armature and field coil insulations are tested with a 300-volt alternating current before leaving the factory. Since all the speeds are obtained with one voltage from an ordinary two-wire circuit the electrical construction of the machine is of the simplest, being of the 4-pole shunt-wound type, requiring no other auxiliary apparatus than an ordinary no voltage release starting box.

Fig. 3 shows the application of the motor to the head stock of a lathe; it will be noticed that the hand wheel is within easy reach of the operator. The instrument under the motor is a starting box only, and is not used for varying the speed.

The line as at present built consists of three sizes of frames giving from 1 to 20 horse power at from 125 to 2,000 revolutions per minute depending on the electrical design of the windings. The speed range may be anywhere from 2½ to 1 up to 10 to 1 as desired by the purchaser. The motors will be wound for 110, 220 or 500 volts direct current. The makers undertake to provide the machine with an efficiency equal to that attained by the best of other makes of variable-speed motors, and will furnish prospective customers with results of tests of any size under consideration; where large installations are planned, they will make comparative tests with other variable-speed motors.

SPRINGFIELD HEAVY DUTY BACK GEARED CRANK SHAPER.

The accompanying half-tone illustrates a shaper specially designed to meet severe service conditions. Massive proportions, ease of manipulation, great driving power and large capacities are the requirements considered in the design of this machine by its builders, the Springfield Machine Tool Co., Springfield, Ohio. The column is internally ribbed throughout, with bored holes for all journal boxes, and has long bearing surfaces for the ram, extended at both the front and back. The ways for the cross rail are unusually deep and extend from top to bottom of the column. The base is large and runs out in front with a raised lip around its edge to retain oil and chips. The ram is internally ribbed in such a way as to afford its greatest strength to bending when it is extended the maximum distance from its bearing. The tool head can be swiveled to any angle and securely locked by two bolts. The feed screw is provided with a micrometer collar reading to thousandths of an inch and can also be furnished with automatic down and angular feed if desired.



The Springfield 25-inch Crank Shaper.

The cross rail is of box section and is rendered self aligning by having one of the ways on the column provided with an angular back face to which the gib fits. By tightening the screws in this gib the rail will always be square. The telescopic elevating screw has a ball thrust bearing. The cross feed screw has a micrometer collar, reading to thousandths of an inch. The box table has large working surfaces on three sides, to any of which work may be clamped. The way in which this table is fastened to the cross slide is somewhat unusual, since instead of securing it by planer bolts in T-slots in the cross slide, three large studs are used which pass entirely through the top of the cross slide above the bearing of the cross rail, the table being clamped by nuts on these studs. This relieves the cast iron of tensile strain, transferring this entirely to the steel studs. The necessity for a support under the table is avoided through the enlargement of the ways on the column, the deeper cross rail, the method of fastening the box table, and the way in which this latter is ribbed.

Wide-faced gears of large pitch are used in the driving mechanism. A four-step cone with the back gears gives eight speeds to the ram. All the shafts of the machine as well as the hangers of the countershaft are provided with approved ring oiling journals. The maximum stroke of the machine is 26½ inches, vertical adjustment of the table 15 inches cross motion of the table 32 inches. The net weight of the machine is 4,600 pounds.

SPRING THREADING TOOL.

Mr. J. W. Eagan, 170 Holland Street, Syracuse, N. Y., makes the spring threading tool shown in two different arrangements in Figs. 1 and 2. As shown in the first cut a V-thread tool made from a square bar of steel is used. The "goose-neck" form given to the holder allows the cutting edge to spring away from the work every time there is a tendency for it to catch, so that even in cutting such materials as cold rolled steel it is easy to avoid a ragged thread. The thumb-screw shown as bearing on the rear end of the blade allows the

Fig. 1

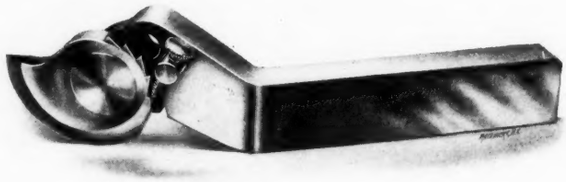


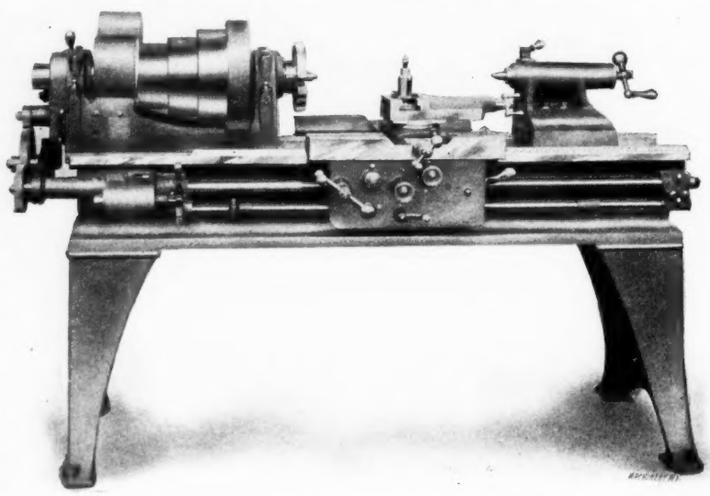
Fig. 2.

tool to reset in its former position after grinding and furnishes as well an abutment which prevents it from tipping up. When used with a circular formed cutter, as shown in Fig. 2, this thumb-screw engages notches formed in the rear half of the cutter to prevent it from being shifted by the pressure of the cut. As arranged in Fig. 1 self-hardening steel bar may be used, no forging being necessary.

SIXTEEN-INCH SPRINGFIELD STANDARD LATHE.

This lathe has been put on the market by the Springfield Machine Tool Co., Springfield, Ohio, with the intention of meeting the demand for an engine lathe which should be fitted for all around service in the machine shop and which should, without being highly specialized, be able to use tools of high speed steel to the full limit of their capacity.

The head stock is driven by a three-step cone of 11-, 9¼-, and 7½-inch diameters for 3¼-inch belt. The spindle may be driven direct or through either of two ratios of back gears of 3 to 1 and 9½ to 1 reduction respectively. This arrangement



Springfield Standard Lathe.

delivers sufficient power to the spindle to allow it to take care of the heaviest work within its range without imparing its utility for rapidly producing work of finer character. The spindle, which has a 1 5-16-inch hole through its entire length, runs in ring oiling bearings which may be replaced with new

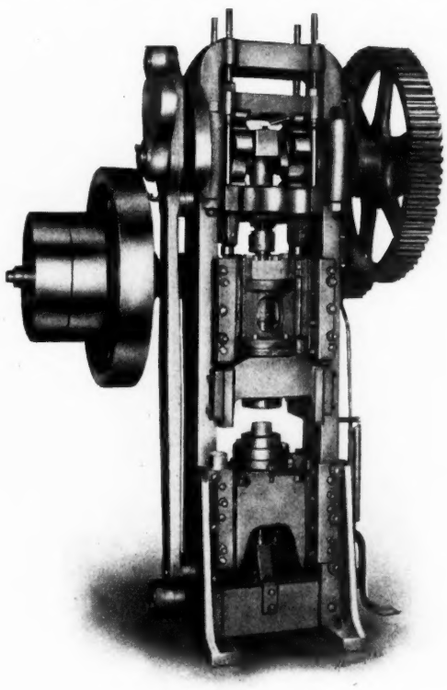
ones in case of accidental damage and still maintain its original hardness.

In the machine shown in the cut six changes of feed are provided for each combination of change gears used at the end of the head stock. With suitable change gears in place for any thread it may be desirable to cut, this change of feeds will have a sufficient range to cover everything required from a heavy roughing chip to a fine finishing feed. The carriage, apron, compound rest, tail stock, and follower rests are all of standard design, very heavy and rigid and supported by a deep and well proportioned bed. The lathe will be furnished with English or metric lead screws if desired, or with the rapid change gear device, oil pan, tank, pump and piping, or such other attachments as may be required to suit the purchaser's needs.

THE BLISS TRIPLE ACTION DRAWING PRESS.

The half-tone below shows the front view of a triple-action drawing press which its makers, the E. W. Bliss Co., 5 Adams Street, Brooklyn, believe to involve a new and valuable principle. The machine is designed for performing drawing operations in sheet metal, the point of novelty in its operation lying in the fact that the work is drawn twice at every stroke of the machine. Briefly this action may be described as follows: The blank is placed on the lower die, which is raised against the stationary blank holder by the rod and cams on the outside of the frame. This holds the blank in place. Next, the outer slide is forced down by the cams to perform the preliminary drawing, after which the eccentric brings down the inner ram to draw the shell a second time. As the punches and dies return to the first position the work is ejected.

This type of press is especially useful and economical for drawing deep seamless shells doing away entirely with annealing first operation shells, inasmuch as the second operation immediately follows the first, while the metal is still warm. Future experience only can determine the full value of the machine, but it is interesting to know that a tin shell 3 inches in diameter by 3 inches deep has been successfully made at one

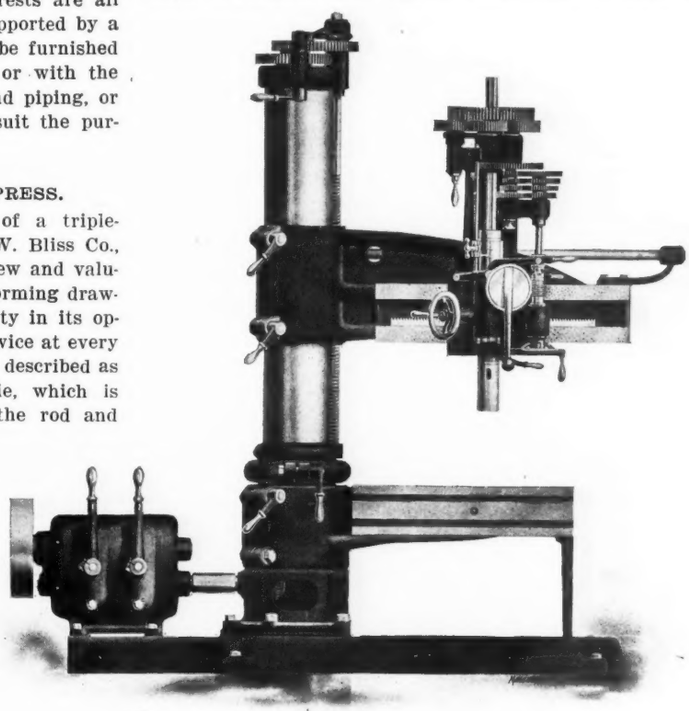


Bliss Triple-action Drawing Press.

stroke of the press. In the size illustrated the capacity is sufficient for a blank 11 inches in diameter and a drawing punch up to 6 inches in diameter. It will draw up to 3 inches in depth and lift out the work for that distance. The press is of very compact construction and occupies no more room than any double-action press of the corresponding size. It may be set in an inclined position to allow the finished shell to fall off by gravity.

AMERICAN TOOL WORKS PLAIN RADIAL DRILL.

The American Tool Works Co., Cincinnati, Ohio, have entirely re-designed their line of radial drills to meet the in-



American Tool Works Radial Drill.

creasingly severe conditions these tools now have to meet. The accompanying cut shows the latest form of plain radial drills with geared drive in the size with three-foot arm. The column is of the double tubular type. The outer sleeve revolves around the central column and is clamped to it in any position by a patented V-clamping ring. The arm has a tubular section to resist the torsional stresses and a parabolic outline to give the proper distribution of metal to afford stiffness against bending pressure. It is clamped to the column by two binder levers and is raised and lowered by power through a convenient lever. The speed box is of the geared friction type with four changes of speed. This in combination with back gears in the head gives eight changes in all. The speed box can be easily interchanged with a cone by simply breaking a coupling connection on the lower driving shaft of the machine since the base is tapped and drilled for either mechanism.

The head is moved on the arm through an angular rack and spiral gear, a clamping lever being provided for binding it in the desired location. The back gears are located in the head thus avoiding the severe torsional stress of the long driving shafts which results from having the back gears at the top of the column or in the speed box. The reversing mechanism for tapping is also located on the head, thus giving frictions the benefit of the back gear ratio and making unusually heavy tapping operations possible, besides permitting the backing of the clamps at an accelerated speed. The lever for starting, stopping and reversing the spindle is controlled at the head from the front of the machine. The feeding mechanism is driven by a set of gears giving four changes covering a carefully chosen range in geometrical progression from 0.0069 inch to 0.0203 inch. These gears while giving all the advantages of the quickness of change and power of action which results from a geared feed, drive the wormwheel through the friction arrangement which permits a drill to be crowded to its limit without danger of breaking.

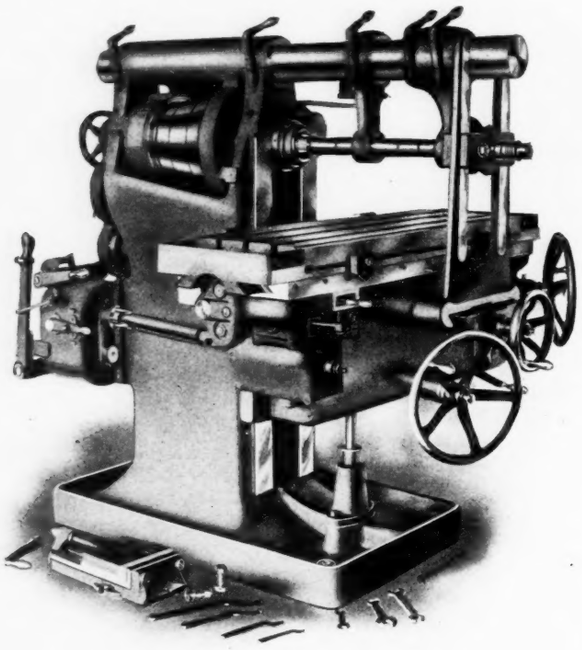
The regular equipment of the machine includes a plain box

table with a top surface of 16 inches x 32 inches, and a side surface of 6 inches x 32 inches, the latter giving the equivalent of an angle plate. Both top and side surface are accurately planed and supplied with large T-slots. Countershaft and cone pulley drive are regularly furnished. At extra cost the speed box above described and illustrated will be furnished, together with swiveling table, round table or improved electric motor application. For the 3-foot size the machine will drill to the center of a circle 6 feet 2 inches in diameter, will take 4 foot 3 inches between the end of the spindle and the base will feed the drill 10 inches in depth and has a traverse of head on the arm of 2 foot 4¾ inches.

NO. 4 BECKER-BRAINARD PLAIN MILLING MACHINE.

The spindle of this machine is of hammered crucible steel with a ¾-inch hole through its entire length and runs in self centering boxes arranged to compensate for wear. It has a slot across the front to engage a corresponding clutch on the arbor and is threaded to take a chuck, this thread being protected by a collar when the chuck is not in use. The driving cone has three steps, of which the largest is 14 inches in diameter and the smallest 11½ inches. A 3½ inch driving belt is used. The spindle is double back-geared 3¼ to 1 and 10 to 1, giving 9 speeds with a single speed countershaft or 18 speeds with a double speed countershaft.

As may be seen from the cut, a positive quick change feed is provided, motion from it being transmitted from the spindle to the feed box through a train of spur gears. Without



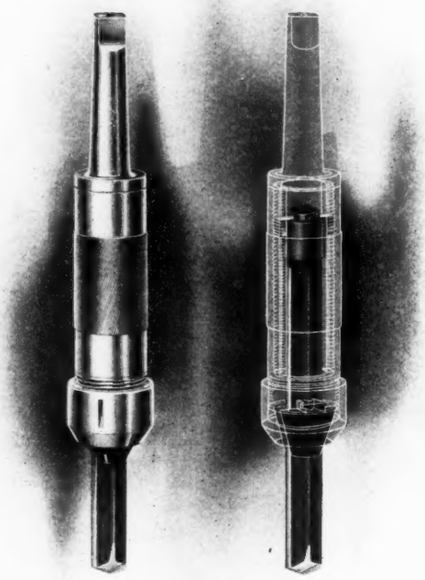
No. 4 Plain Milling Machine.

stopping the machine, twenty changes of feed sufficient to cover the working range of the machine may be instantly attainable. The power feed is applied to the longitudinal movement of the table, cross movement of the saddle, and the vertical movement of the knee, all the handwheels for operating these movements by hand being permanently attached to the machine and provided with a clutch mechanism which allows them to be disengaged when not in use.

The overhanging arm is of steel designed for horizontal adjustment and has an arbor support which may be removed so that any of the attachments may be placed in position without necessitating the reversal of the arm. The net weight of the machine is about 7,100 pounds. The table is 60 inches by 16½ inches over all with a length of feed of 46 inches. The cross feed is 14 inches and the vertical movement of the knee 20 inches. The end of the spindle is bored to No. 12 Brown & Sharpe taper. The machine is built by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

THE RICH DRILL AND CHUCK.

The drill, and the chuck for holding it, which are shown in the accompanying cut have resulted from the attempts of its makers to design the best possible tool for drilling holes in hard materials with drills of modern high-speed steel. This flat drill is made from a bar of the best material obtainable for the purpose, is rolled to the required shape, tempered carefully throughout its entire length and ground afterwards to accurate size. The chuck in which it is used is long enough to support a full length drill close to the cutting edge when working in short holes. As the tool is worn down by the sharpening of the cutting edge, the adjustable abutment shown in the sectional view of the chuck is screwed out to keep the drill projecting the proper amount. Both the gripping of the jaws on the drill and the adjustment of the abutment are controlled by knurled collars on the outside of the chuck.



The Rich Drill and Chuck.

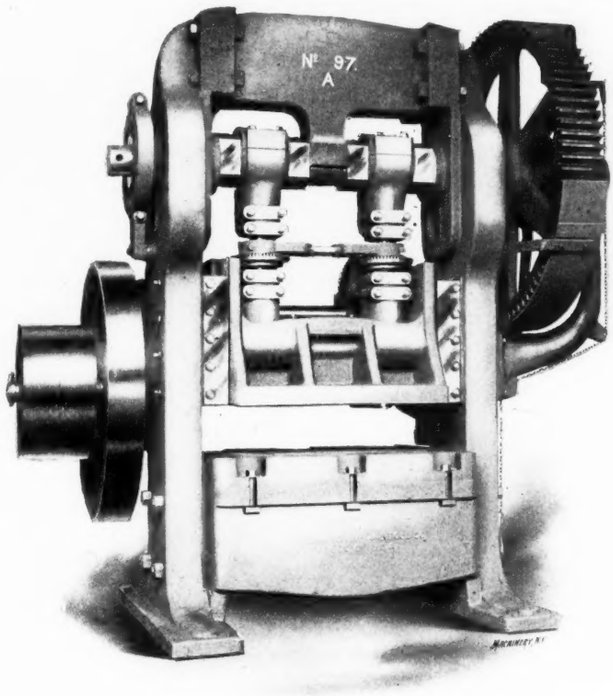
The makers, the Geo. R. Rich Mfg. Co., Buchanan, Mich., report favorable results from a large number of tests of this tool in competition with ordinary twist drills, twist drills of high-speed steel, and forged flat drills of various lengths and diameters. Some of these tests were made under government supervision at the Brooklyn Navy Yard. Ten holes were drilled in armorplate turrets on the Battleship Connecticut with a 1¼-inch Rich flat drill when eight twist drills had been used without finishing one hole.

The advantages of these drills may be summed up as follows: Being made of high-speed steel they will take heavier feeds and run at higher speeds than will ordinary twist drills; their strength and endurance suits them for materials too hard and tough for ordinary tools; they will retain their sharp cutting edges much longer than twist drills and are more easily sharpened when dull, being tempered throughout their length they can be used to within two inches of the end, permitting the maximum economy in the use of the expensive material of which they are made; if the drill is broken either of the pieces, if longer than two inches, may readily be ground to a cutting point and used again; they are much stronger torsionally than twist drills; they are so held that only so much of the drill will project from the chuck as is necessary to penetrate the piece being drilled.

DOUBLE PITMAN BLANKING PRESS.

The press shown in the accompanying half-tone was designed for use in the large electrical manufacturing concerns of the country, for special blanking, and compound perforating and cutting dies of extra large size. Its usefulness of course is not limited to this class of work as it is adapted for all heavy blanking and forming operations within its range.

The frame is of the four piece type, the housing being unusually heavy at the shaft opening, which practically eliminates the liability of fracture through accident at this point. Both the bed and the arch take the thrust of the die against solid abutments on these side housings, making the whole structure nearly as efficient as a solid casting would be. In addition to these abutments for taking the thrust, each joint is held together by four heavy bolts on each side machined to fit reamed holes. The crankshaft and connection screws are made of high carbon hammered steel. The connection screws are fitted with bevel gears and pinions for quick and positive adjustment. To give all the strength possible to this adjustable connection, the four threaded caps which are tightened down on the screws to lock them, are machined and scraped to a shoulder bearing, in this way throwing the strain in heavy work directly onto the solid metal of the connection. The lower connections are machined to fit the solid metal in the slide, thus making use of the shaft or stud for lifting the slide only. The press is double back geared with a ratio of 30 to 1. The gearing is machine cut from the solid, the clutch gear running loosely on the shaft outside the main bearing. The clutch faces on the gear and the steel clutch collar are fitted with three hardened tool steel surfaces each.



A Large Toledo Blanking Press.

This feature is not very distinctly shown in the cut. The clutch is of the three engagement pattern, released by means of a weight which throws the releasing roll in contact with a cam on the steel collar. The gravity release gives a more positive action than does the use of a spring for actuating the releasing clutch. The outer arm which may be seen running out beyond the large gear is used for supporting the gravity releasing adjustment only, and not as an outboard bearing to the main shaft.

Some of the measurements of this machine are as follows: Width between uprights, 61 inches; slide area, 32 inches front to back, and 41 inches right to left. Bed area, 48 inches front to back, 60 inches right to left; bed opening, 32 inches front to back, 48 inches right to left. Ratio of gearing, 30 to 1. The press has a capacity of about 60 tons pressure and weight 72,000 pounds. The builders, the Toledo Machine & Tool Co., of Toledo, Ohio, furnish these machines in fifteen different sizes. The construction is such that various widths between uprights may be obtained, ranging from 60 inches to 96 inches, or greater.

AN INK FILLER FOR RULING PENS.

The accompany illustration shows a handy filler for ruling pens that has been placed on the market by Armand W. Benoit, Tufts College, Mass. This filler is designed to take the place of the ordinary quill filler supplied with Higgin's ink now so universally used by draftsmen. It consists of a stopper similar to that usually provided but it is fitted with a small pipette consisting of a rubber bulb and a glass tube. The tube being of small diameter carries little or no ink on the outside when the filler is removed from the bottle, thus enabling the

An Ink Filler for Ruling Pens.

operator to control the amount of ink supplied to the pen. The tube is small enough to enter between the nibs of the pen and does not trouble by depositing ink on the outside, which is one of the annoyances of the quill filler, making it usually necessary to wipe off the outside of the nibs after filling. Although the tube is of glass the danger of breaking through accidentally dropping is slight as the bulb is much heavier than the tube and will always strike the floor first. In using this filler it is not necessary to shake or invert the bottle after the ink has become half used up. It may also be used to withdraw ink from the pen if desired, instead of wiping it out.

SCREW SLOTTING DEVICE.

A new screw slotting device designed primarily for use with the "Cataract" bench lathe is shown in the half-tone. The base, as may be seen, is intended to be clamped to the bed of the lathe; a V-block supported by a stem may be clamped in the base at a height determined by the knurled nut which is threaded upon it. Within this V-block may be placed a

Screw Slotting Device.

square chuck holder fitted to receive the regular spindle chucks furnished with the machine. This chuck is tightened by the small hand wheel shown and is limited in its movement by the lock nuts which are threaded to its rear end. The way in which it is used will be readily understood. The The work is gripped in the chuck and fed to the saw or cutter mounted in the lathe to a depth determined by the ad-

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justable nuts. The work may be removed and a new piece substituted which will be operated upon by the cutter in the same way, since the relations of the work and cutter are not disturbed. The device may be quickly applied to the lathe for such jobs as screw cutting, repairing, model making, tool making, and even for some manufacturing work it is economical and practicable. The tool is manufactured by Hardinge Bros., Chicago, Ill., and will fit in any standard bench lathe.

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FRESH FROM THE PRESS.

MANNHEIM & MULTIPLEX SLIDE RULES. By L. W. Rosenthal. Published by Eugene Dietzgen, 119 to 121 West 23d Street, New York City.

This pamphlet is divided into three sections, the first of which is a general treatise on slide rules. The second deals with multiplex slide rules made by this company, giving full directions for their use. Part third is devoted to tables and conversion ratios.

MACHINE SHOP ARITHMETIC. By Colvin and Cheney. Published by the Derry Collard Co., New York. New edition. 144 pages. Illustrated. Price, 50 cents.

This little book has passed through many editions and appears to be more popular than ever with machinists and mechanical men. It explains calculations most used by shop men, but it does not give these in a rule-of-thumb manner. It outlines in each case the principle of the calculation so that a person will understand what he is doing and why he is doing it. There is therefore no chance to go wrong if a person takes pains to read the explanations given. There have been some additions in this new edition. They include metric threads, force, shrink and running fits, etc. The book is now bound in flexible covers.

HYDRAULIC POWER ENGINEERING. By G. Croydon Marks. Published in this country by D. Van Nostrand Co., 23 Murray Street, New York City. 388 pages. Illustrated. Second edition, revised and enlarged. Price, $3.50.

This treatise deals with hydraulic motors and turbines and with various types of other hydraulic machinery, such as cranes, accumulators, hydraulic presses, etc. The present edition has been enlarged by the addition of material especially upon hydraulic presses and lifting machinery, there being about 40 new illustrations. Pumps are dealt with only to a limited extent. Numerous types of controlling valves are shown for elevators, cranes, presses, etc. The treatment of turbines is less mathematical than in most works, but appears to be satisfactory and includes calculations involved in turbine design. The illustrations are well executed and the book is useful as a general work of reference on different types of hydraulic machinery.

KLINE'S PIECE WORK RATE SETTING TABLE is the title of a book compiled by Archibald L. Kline, Chicago, Ill. It is bound in morocco and printed on ledger paper, and is pocket size. Published by Glenum and Kern, 265 La Salle Street, Chicago. Price, $5.00.

The piece work system is now almost universally adopted in all large industries in the United States. This system has greatly increased the labors of those whose duty it is to make the estimates thereof. Mr. Kline's book consists of tables prepared for his own use in a large manufacturing plant, and they have been found so useful that they are now presented in book form. They are arranged in four main divisions—seven, eight, nine and ten hours, representing the different lengths of day's work. Each of these tables, in turn, is again arranged into sub-divisions of seconds, minutes and hours. The tables apply to wages ranging from 75 cents to $5.00 per day, showing piece rates per 100 pieces, and time required to do one piece, the number of pieces per hour and the number of pieces per day.

The reason for having four divisions is explained as follows: A shop working ten hours cannot expect its employes to work every second in the day, as there is time lost in taking care of the machine, sharpening tools and other justifiable loss. The actual working hours are best determined by the foreman or the man in charge of the work. If the time lost is one hour, then the piece rate should be set by using the nine-hour table.

In the use of the tables it is necessary to know the time required for completing each piece, or the number of pieces completed in a day. This can be best ascertained by the use of a stop watch. For example, suppose the actual time is nine hours, and it is desired that the employe shall earn $2.25 per day. It takes 21 seconds to complete a piece. Look up this time in the suitable table and find the corresponding number of pieces that can be done in one hour at that rate of speed and the number that can be completed in a day. Under the wage column of $2.25 is found the rate to be paid per 100 pieces.

NEW TRADE LITERATURE.

THE WATSON-STILLMAN CO., 46 Dey Street, New York City. Catalogue No. 68, dealing with Hydraulic Jacks. This is another edition of No. 61, and contains some new sizes and a few new cuts. Several new pages are inserted in the back, listing their various catalogues.

THE AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 186, devoted to A. B. C. Heaters. A general description, description of construction and capacity are taken up, and various types of heaters, in combination with fans, are illustrated.

HENRY & WRIGHT MFG. CO., 111-137 Sheldon St., Hartford, Conn. Catalogue of Ball Bearing Drill Presses and Filing Machines. Illustrations of a number of different types are given and several pages are devoted to the Idler system. The Hartford Bench Filing machine is also described and illustrated.

CRANE CO., Chicago, Ill. Advance Circulars Nos. 01, 2, 3, 4S. D. V., 5, 6, 7, 8, 9, 10, 11, 12C. S. T., 14, 15, 17, 18, 19 and 20. These treat of steam and oil separators, various types of valves, pipe dies, heavy flanged pipe joints, reversible stop and waste cocks, brackets, hangers, supports, rolls and anchors, steam traps, drip pockets and pipe bends.

LODGE & SHIPLEY MACHINE & TOOL CO., Cincinnati, O. Catalogue R, containing descriptions of their various lathes, which are designed especially for the use of high-speed steel. This catalogue takes up details and specifications of the engine lathe, patent head lathe and accessories. It presents an attractive appearance, being an artistic piece of printer's work, and illustrated with excellent engravings.

THE B. F. STURTEVANT CO., Boston, Mass., will hereafter issue most of its publications periodically under the title, "Sturtevant Engineering Series." Each individual bulletin will treat of some particular product or its application. The series will also include reprints of pertinent articles or technical papers. All publications will be issued in uniform style and size suitable for binding consecutively or in allied groups. Bulletin No. 125, the first of this series, has just been published. It describes in detail the line of automatic vertical engines manufactured by the B. F. Sturtevant Co.

MANUFACTURERS' NOTES.

THE DIAMOND CHAIN & MFG. CO., Indianapolis, Ind., have taken up the manufacture of automobile parts, and are now prepared to furnish same to trade.

H. W. CALDWELL & SON CO., Chicago, Ill., have secured the services of Howard W. McLean, who was for a number of years superintendent of the Link Belt Mchy. Co., as consulting engineer.

THE F. W. SPACKE MACHINE CO., Indianapolis, Ind., manufacturers of air compressors, have outgrown their old plant and will break ground in thirty days for a large addition to their factory.

THE FREVERT MACHINERY CO., New York City, have opened their new salesrooms at 18 Dey Street. They handle a full line of new and second-hand machinery, traveling cranes, hoists, etc.

THE well-known company of Pedrick & Ayer, formerly of Philadelphia, now located at Plainfield, N. J., has been purchased and will hereafter be operated by the Railway Appliances Co., Chicago.

MCDOWELL, STOCKER & CO., Chicago, Ill., announce the opening of a branch office in Milwaukee, Wis., Room 51, Loan and Trust Building, Second Street and Grand Avenue. The office will be in charge of J. R. McDonald.

MR. ARTHUR FALKENAU announces that he has retired from his manufacturing and engineering business and has opened an office as consulting engineer and expert, 919-920 Witherspoon Building, Philadelphia.

THE TOLEDO MACHINE & TOOL CO., Toledo, O., designers and builders of special machinery as well as a long line of bar and sheet metal working tools, report a most gratifying increase in their export trade. They are making heavy shipments to France, Germany, Belgium and Holland, and are also doing an unusually heavy business in Canada.

THE EDGMONT MACHINE WORKS, Dayton, O., have recently become incorporated under the laws of Ohio as the Edgmont Machine Co., with a capital of $15,000. The president is George Stahl; secretary, W. P. Coffman; treasurer, J. I. Coffman. The firm will be engaged in manufacturing clutch pulleys.

THE CLEVELAND PLANER WORKS, Cleveland, O., manufacturers of open side planers, have made a large addition to their factory, which more than doubles their floor space. They expect that their increased facilities will enable them to more easily handle their growing business.

THE BATES FORGE CO., Indianapolis, Ind., have just installed a new 4,000-pound Chambersburg steam hammer which will enable them to better care for their rapidly increasing business. They report a specially good business in their truck and sheave wheels, which are forged from bar steel and have half the weight and double the strength of castings.

THE S. OBERMAYER CO., Cincinnati, O., have recently purchased the foundry supply factory of H. S. Vrooman, Chicago. The entire factory of this concern as well as their stock of merchandise has been moved to the Chicago plant of the S. Obermayer Co., from where all orders of this department will be filled.

L. BEST announces that his business will hereafter be carried on by the L. Best Co., a corporation organized under the laws of the State of New York, having the exclusive agency for the sale of the Sterling emery and corundum wheels. They will also manufacture and sell emery grinding and polishing machinery and polishers' supplies. The general management of the business will remain as before.

C. H. BESLEY & CO., 15-21 S. Clinton Street, Chicago, Ill., report shipment of their spiral grooved disk grinders during the past week to Cologne and Berlin, Germany; Milan, Italy; and Athena, Greece.